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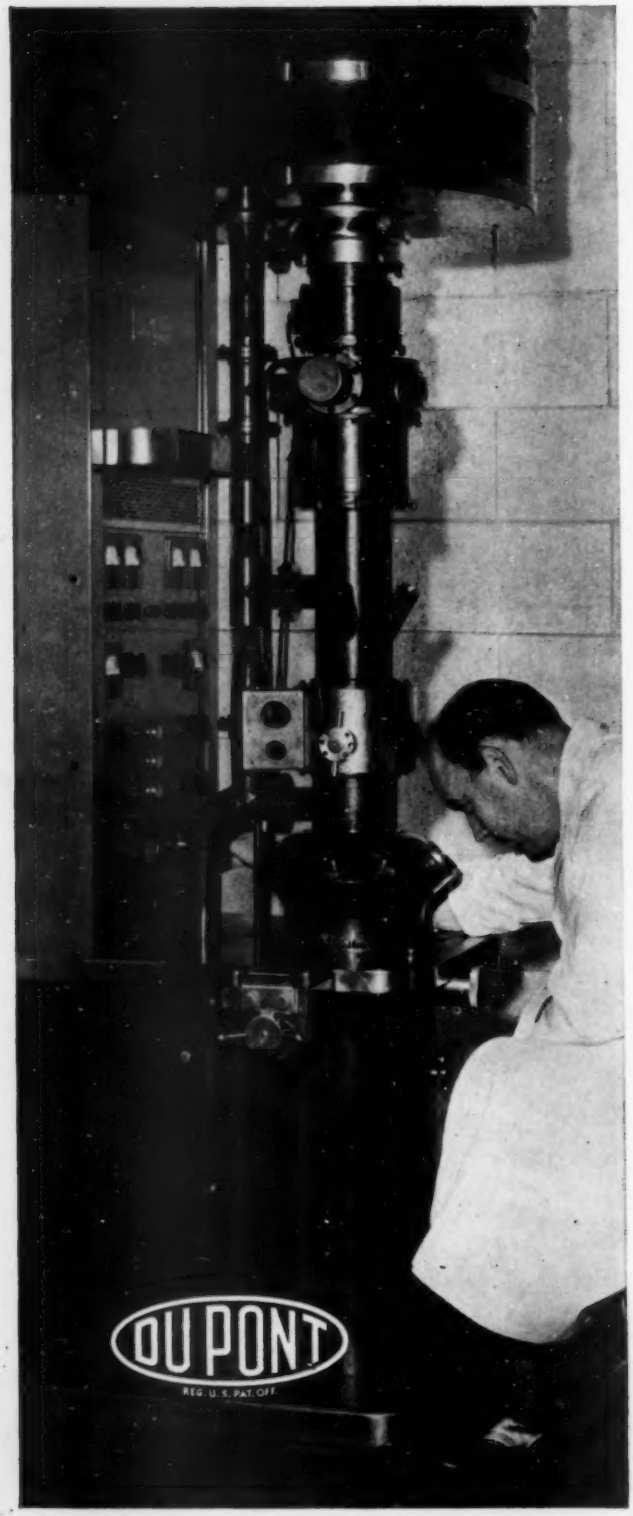

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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OSSEOUS METASTASES FROM GRADED CANCERS OF THE BREAST

WITH PARTICULAR REFERENCE TO ROENTGEN TREATMENT

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ELMIRA, NEW YORK

OF ALL the metastatic malignant lesions in bone, those occurring secondary to cancer of the breast are the most common. In a review by Sutherland, Decker and Cilley,[64] of the Mayo Clinic, of 1,032 cases in which there was roentgenological evidence of metastasis to bone, 393 (38 per cent) were traced to a primary source in the breast. This figure is roughly similar to the 30 per cent figure of Copeland[14] reporting on 334 cases of osseous metastasis studied at Johns Hopkins Hospital and to the more recent 36 per cent incidence of Fort[20] at Stanford University Hospital and San Francisco County Hospital based on 112 such cases in which positive roentgen diagnosis of skeletal metastases had been made. The frequency with which metastasis to bone occurs from cancer of the breast has been difficult to determine. Necropsy studies by various observers have shown the incidence of such metastasis to vary between 20.5 and 73 per cent. Notable among these reports are those of: Gross[29] reporting 20.5 per cent incidence in 425 autopsied cases with breast cancer; Handley[30] finding an incidence of 22 per cent in 329 necropsies at the Middlesex Hospital from 1872 to 1891; William[66] in 1908 reporting a figure of 26.5 per cent based on 893 such postmortems reported in the literature; Risley,[58] 25 per cent; Kaufmann,[40] 53.3 per cent in 63 autopsied cases; and Ginsburg [24,25] reporting 75 per cent incidence of bone metastases in a series of such cases carefully examined postmortem at the Montefiore Hospital. Osseous metastasis from cancer of the breast is a terminal event, and is one manifestation of the generalized extension of the disease throughout the body. Therefore, its incidence should approach 100 per cent in those patients in whom cancer of the breast is the primary cause of death. One cannot help feeling that the percentage-incidence of bone metastasis from the breast varies with the thoroughness with which the patients are examined for bone lesions, and that the higher percentages reported more nearly approach the true frequency.

Though frequently emphasized by recent writers, the fact that cancer of the breast may metastasize to bone early is not yet taken seriously enough in clinical practice. Metastasis may already be present in the spine or pelvis without sign or symptom at the time the primary tumor is first discovered in the breast. On the other hand, it may delay its appearance up to twenty years or more after removal of the primary breast lesion. Both types of occurrence have come within my clinical experience.

Skeletal metastases from cancer of the breast may occur in any location. The most frequently noted locations of osseous metastases from cancer of the breast are the spine and pelvis, according to such observers as Stenstrom and Ericksen,[63] Sutherland *et al.*,[61] Copeland,[13] Fort,[20] Kaufmann,[40] Lee and Herendeen,[43] Lee and Tannenbaum,[44] and many others. With somewhat less frequency metastases occur in the upper femur, ribs, sternum, skull and upper humerus. Rarely are osseous metastases, particularly from the breast, seen below the knee or elbow. Only 3 or 4 such instances are reported by Stenstrom and Ericksen in a study of 115 bone metastases from cancer of the breast.

Why skeletal metastasis from cancer of the breast should occur most frequently in the vertebral and pelvic bones is not known. Indeed, the existence of deposits of malignant breast tumor in the bone marrow had been realized by pathologists and clinicians a considerable time before any definite explanation of the fact was available. The early conception of the formation of deposits of cancer in the bone marrow depended upon a belief in the existence of a "cancerous diathesis" which was capable of manifesting itself in different regions of the body at the same time or successively. Thus, Sanson,[60] in 1834, described a case in which a woman with a scirrhous cancer of the breast of less than one year's duration broke a femur while turning in bed. During the manipulations necessary for reduction of this fracture, the other femur broke. Later, at autopsy, multiple deposits were found throughout the skeleton, and Sanson cited this case as a most complete example "of that which one calls cancerous diathesis." It soon became obvious, as knowledge in pathology increased in the years following, that the explanation of the process of the formation of metastases was to be looked for in the blood or lymph; that the bone deposits represented cancer cells that had traveled from a single primary source to the point found, where they were growing as secondary tumors.

A considerable controversy has grown up as to the mechanism by which malignant cells are carried from the primary cancer to the vertebrae and pelvic bones. Lymphatic extension by permeation, lymphatic emboli, and embolic dissemination by way of the blood stream, each has its ardent supporters. Von Recklinghausen[57] was among the first to champion blood stream dissemination of malignant tumor to bone marrow, the so-called embolic theory. His support of this theory was based on his finding that metastases in bones occur within the medullary cavity, and reach the periosteum only by extension from the interior; that when subperiosteal tissue was invaded it was always in the region of the large foramina, which serve as points of egress for large veins; that the individual cancer cells in the marrow lay within definite channels which were arranged in a manner similar to that of the veins present in marrow; that all blood channels in the invaded area had tumor cells; and lastly, that there was no evidence of lymphatic channels in the medullary cavity. Piney[55] likewise concludes that metastatic deposits in bone are due to arterial or capillary embolism, and brings forth as evidence the detection of cancer cells in the vascular channels in the bone marrow. The vascular nature of these channels is demonstrated by the fact that they contain red corpuscles in addition to the epithelial cells. Piney attempted to demonstrate lymph vessels in bone by the injection method so successfully used for studying lymph vessels in other locations, but was unsuccessful. Piney observes that the bones which have red bone marrow, ribs, sternum, vertebrae, innominates, and upper ends of the humerus and femur, are most likely to be the seat of metastases, and states that anatomically and physiologically, in the red marrow bones, the wider stream bed, the slower circulation, and the more complicated course of the vessels are conducive to emboli lodging at these points. The circulation in fatty marrow, on the other hand, he says, is quite normal. Schmidt[62] was able to show that small

thrombi containing cancer cells were present in the capillaries of the lungs, even in cases where there was no evidence of tumor in these organs on ordinary examination. Many of the epithelial cells in such thrombi appeared to be destroyed; but he was able to observe that they might, on occasion, grow through the thrombus material, and in this way pass into the venous side of the pulmonary circulation, and thus reach the systemic circulation. Neal and Robnett[50] report a case supporting the blood borne theory in which they state that "there was a frank absence of permeation of fascial lymphatics near the invaded bone."

Handley contends, from detailed study of many cases, that "bone deposits in breast cancer are usually secondary results of far-extending growth of cancer along the deep fascial lymphatic plexus." By direct retrograde permeation of the lymphatics, the periosteum of the bones is reached. "Since lymphatics and veins always run together, infiltration of the wall of the concomitant vein is a likely event, and subsequent extension in the bone may take place, as Piney has shown, along the blood channels." He states that "Piney has not adduced any evidence that the cancer cells in the first instance reach the bone by the blood stream," and cites the great infrequency of bone deposits distal to the knee and the elbow "though non-cancerous emboli are known to lodge with special frequency in the distal portions of the limbs." Carnett,[10] from similar observations of his own, accepts the lymphatic permeation theory of Handley. Kolodny[41] reports a direct relationship between the bone marrow and the lymphatic system. He injected three to five drops of india ink into the medullary cavity of bone marrow in dogs and killed the dogs one to three weeks later. Examination of the regional lymph nodes showed dye grossly present in twelve to fourteen days, microscopically present in five to seven days. He also found actual lymphatic channels in bone containing the dye. Kolodny concludes that "bone marrow is directly related to the lymphatic system. It drains its lymph into certain groups of lymph nodes, the regional lymph nodes of the respective bone. . . . Deviations from the normal in the flow of lymph, namely, the aberration of the lymph stream, the retrograde lymph stream, and the reflux lymph flow, can lead to the metastatic spreading through the skeleton of carcinomatous cells transported in the lymph circulation from the primary tumor."

In conclusion, on the basis of the evidence in hand to date, it would seem that metastases to bone can undoubtedly occur by way of either the blood or lymph channels, although the arguments of von Recklinghausen and his supporters appear as yet the more alluring, and suggest that blood embolus is the more usual route.

In 1891 von Recklinghausen described two types of bone metastases: one, diffuse and destructive, which he termed osteomalacia carcinomatosis; and a second type, osteoplastic in character. It is generally accepted that these two types of manifestation exist. In the former the cortex is destroyed, so that fracture may easily occur; in the latter there is new bone production, and the bone may become heavier and even larger. Askanazy[1] believed that metastasis first produces osteoporosis, which is followed by necrosis, and that such necrotic bone acts as a foreign body to produce new bone. Von Reckinghausen noted that the osteoclasts present in osteoporosis were seldom seen in spreading metastatic areas. He felt that softening of the bone and removal of the inorganic salts took place without their presence—that the tumor first destroyed bone and then grew by occupying the space it produced. New bone formation he attributed as due to hyperemia and hemostasis in the region of the tumor, from obstruction of the capillaries by endovascular tumor emboli. Levin[47] did not find hyperemia and felt that some chemical irritant emanating from the cancer cells acted on the bone, stimulating its proliferation. Kaufmann maintained that a metastatic bone deposit is always surrounded by a zone of inflammation, and this caused the

sclerosis. This non-infectious inflammatory reaction accompanying the development of tumor has been emphasized by Ewing[19] and others.[26] Pfahler[53] feels that the resultant sclerosis is an indication of Nature's attempt to isolate the disease. It is observed that this process is enhanced by roentgen therapy, and is called by Geschickter and Copeland[22] fibro-ostosis. Cave[12] recently expressed the opinion that the type of metasis is dependent on the path of its entrance into bone. When the cells are blood borne he believes that osteolysis results, and when the tumor reaches bone through lymphatic permeation, osteoplasia results. It appeared to Gray[27] that the thing that determined whether the metastases were osteoplastic or osteoclastic was the type of primary breast tumor, and whether it was rapidly malignant or slowly growing. Thiele[65] believed that the more infiltrating, the less sharply defined and the more slowly growing the primary neoplasm and its metastases are, the greater will be the tendency to osteoplastic change. Downs[16] and Downs and Hastings[17,18] have noted somewhat of a parallelism between the degree of desmoplasia in the primary tumor and the appearance of osteoplasia in its metastases. Leddy[42] states that, superficially, there is no relation between the histopathologic character of the tumor and the incidence or type of metastasis.

Bone metastases from cancer of the breast are predominantly of the osteoclastic character. The sclerosing type was noted in only 2 of 100 cases of Geschickter and Copeland.[22] Lenz and Freid[46] report the type of metastasis in breast cancer as osteoclastic in 77 per cent, and in 23 per cent mixed changes of both osteoplastic and osteoclastic character. Carnett and Howell,[11] reporting on 101 cases with bone metastasis from breast cancer, state that all but two were destructive in type, the two exceptions being associated, in addition, with some osteosclerosis. Sutherland, Decker and Cilley, reporting on the roentgen examination of 393 patients with bone metastasis secondary to cancer of the breast, graded 375 growths as osteoclastic, 5 as mixed osteoclastic and osteoplastic, and 13 as definitely osteoplastic. Levin reports that, microscopically, all cases show both osteoplasia and osteoclasia, with one or the other predominating.

SYMPTOMATOLOGY

The presence of cancerous tissue in bones causes, *per se*, no pain. Metastatic lesions may be present and symptomless for months and even years. At the Mayo Clinic are frequently seen extensive multiple bone metastases in individuals with no sign or symptom except the pain coming from one area of involvement. Pain is, however, usually the first warning, clinically, of the presence of bone metastasis, and does not occur until the periosteum or nerve trunks adjacent to bone become involved by the metastasis or the surrounding inflammatory reaction. Pain may be of two types: local pain, originating through pressure on the periosteum or on the sensory nerves that supply it, resembling pains seen in incomplete fractures, frequently associated with tenderness; and neuralgic pain, such as that seen in "sciatica," pain arising from pressure on adjacent nerves, especially at the points of entry into the intervertebral foramina, and radiated over the entire sensory distribution of the nerve involved. Pain may be mild or transitory at the outset, consisting of an occasional catch in the back, or stiffness, but almost always as time goes on, the pain becomes more severe and constant. An outstanding characteristic is the exalted sensibility of the part involved to jarring, jolting movements. In a series of cases reported by Leddy, the pain was severe in 95 per cent of cases, and in nearly half of these it was described as excruciating, agonizing, or crippling, and in itself presented the major clinical problem. Spontaneous remission of pain did not occur in a single case, although such occurrences have been reported in the literature.[19]

Not rarely the first indication of a metastasis is the occurrence of a pathologic fracture, the fracture of a humerus as the individual props herself up in bed, the fracture of a femur while alighting in the usual manner from a car, the compression of one or more vertebrae while lifting a heavy object. A pathologic fracture occurred at some time or other in the course of events in 15 of the 100 cases of cancer of the breast with bone metastases studied by Geschickter and Copeland. Collapse of the vertebrae may produce compression of the cord, which is occasionally associated with paraplegia and vesical disturbances.

Skeletal metastases may exist for months without much anemia or cachexia, without marked weight loss or emaciation. These are usually more terminal events, at which time are also present, as a rule, internal metastases to more vital structures.

DIAGNOSIS

Suspicion of the existence of bone metastasis from cancer of the breast is based on the history of or presence of a primary breast lesion and the occurrence of pain, no matter how slight, in any portion of the body, especially in the lower back. Rheumatic pain requiring morphine, particularly, as Rynearson and Hench[59] have emphasized, should suggest metastases. In such a situation it is wise to consider metastasis as the most likely explanation, and attempt to establish a positive diagnosis with the aid of the roentgen ray. In the great majority of cases, the presence of bone metastasis can be determined by roentgenographic studies. Occasionally, however, as has been our experience as well as that of Lenz and Freid, Geschickter and Copeland, and others, pain may precede positive roentgen evidence by several months. If the roentgenogram of the part is negative, the patient should be kept under observation, and if the pain continues for more than a few days without other very apparent cause, it is best to establish a tentative diagnosis of metastasis and to treat accordingly with roentgen therapy. Roentgenograms taken at later intervals may reveal positive evidence, though originally they were negative.

If pain, from the dorsal spine, for example, leads to the finding of a metastatic area, taking roentgenograms of the rest of the spine, pelvis, ribs, and less frequently, other bones, may reveal many additional metastatic areas as yet without clinical symptoms.

As has been said before, metastases from cancer of the breast are predominantly of the osteoclastic type. They are characterized in the roentgenogram by sharply demarcated, though irregular, areas of decreased density in the bone, often presenting a diffused honeycombed appearance at times, with almost complete involvement of the bone, without, however, altering the cortical silhouette. Osteoplastic changes are evidenced by an irregular increase in density, a chalky appearance, often bordering on or associated with the areas of destruction, but without cortical or periosteal thickening.

PRESENT STUDY

From a review of the literature it can be seen that much has been written and many theories have been expounded regarding the relationships between the primary cancer in the breast and bone metastases subsequent to it. Significant relationships have been implied between such changes as desmoplasia in the primary tumor and osteoplasia in the bone metastases. In series of bone metastases the number secondary to scirrhous carcinoma, adenocarcinoma and medullary carcinoma of the breast have been noted. The bearing that the type of treatment given the primary tumor has on the time of occurrence of bone metastases has been recorded, and the subsequent course of the patient after the occurrence of bone metastases has been discussed.

The present study was initiated as an endeavor to shed more light on some of the relationships existing between the primary

breast cancer and the character and course of the later occurring bone metastases. The principal object was to determine the influence or bearing which the *type* of the primary breast cancer might have upon the time of occurrence of bone metastases and upon the response of the metastases to roentgen therapy. Because of its previously demonstrated value in the prognosis of tumors arising elsewhere, and its similar prognostic import in breast cancer as already so well shown by Harrington,[32,33,34] the Broders[7,8,9] system of grading of malignancy was followed in this investigation. In the grading, according to Broders' method, the microscopist estimates the proportions of the cells that are partially or completely differentiated on the one hand, and those that are more or less undifferentiated, on the other. The results are expressed in numerals from 1 to 4, as follows: A cancer graded 1 is one in which the proportion of differentiated cells range from almost 100 down to 75 per cent, that of the undifferentiated cells from practically 0 to 25 per cent; in a cancer graded 2, the proportion of differentiated cells ranges from 75 down to 50 per cent, that of undifferentiated cells from 25 up to 50 per cent; in cancer graded 3, the proportion of differentiated cells ranges from 50 down to 25 per cent, and that of undifferentiated cells from 50 to 75 per cent; and in a cancer graded 4, the proportion of differentiated cells is from 25 per cent to practically 0, that of the undifferentiated cells from 75 per cent up to 100 per cent. As far as we know, this is the first study of bone metastases from breast cancer in which the primary tumor was graded according to Broders. Because the cancerous bone deposits most frequently occurred in the spine and pelvis, and in order to better draw comparisons between the results of treatment in the different cases, this investigation was limited to those cases in which metastases to the spine or pelvis were present.

Approximately 200 individuals with bone metastases from cancer of the breast were seen and treated in the Section on Roentgenology at the Mayo Clinic between January, 1925, and January, 1934. Of these 200 cases, only those complete in *all* the following prerequisites were used for this analysis. The requirements held necessary for admittance to this study were six in all, and are as follows:

1. Radical amputation of the breast, performed at the Mayo Clinic;
2. Subsequent microscopic study and grading of the tumor thus removed;
3. Clinical evidence suggestive of metastases to the spine or pelvis;
4. Roentgenographic demonstration and confirmation of the presence of such metastases;
5. Roentgen treatment of the metastatic area or areas in the Section on Roentgen Therapy;
6. Records of the results of the treatments.

Most of the 200 cases were complete in all but one or two of these details. Many had had the breast operation elsewhere, and had no report as to the grade of malignancy found. In some, roentgenographic evidence of metastases was not shown although the clinical evidence and course seldom left any reasonable doubt as to the correctness of the diagnosis. In a few, all facts were known except the results of treatment. Forty-one cases were complete in all respects, and formed the basis for this study. An additional case fulfilled all requirements, but developed a primary cancer in the other breast of a different grade from the first primary lesion.

Of the 41 patients, 23 had cancer of the right breast, and 18 of the left breast. The average age, at the time of operation, for the entire group was 47.6 years, with a range from twenty-nine to sixty-seven years of age. Grouping the patients according to the grade of their malignancy, the average age of each group at the time of operation varied less than a year from the average for the entire series. Age of patients (Table 1) with Grade 2 malignancies, ranged from 40–60; with Grade 3 malignancies, from 35–67; with Grade 4 malig-

nancies, from 29–63 years of age. The wider range of age of Grade 3 and Grade 4 may not be of any significance, inasmuch as most of the cases fall in these grades.

Twenty-two, or 53.6 per cent, of the 41 cases, fall into Broders' Grade 4 classification; 13, or 31.7 per cent, into Grade 3 classification; and 6, or 14.6 per cent, into Grade 2. No case with bone metastases from Grade 1 malignancies was found.

According to Harrington who studied the gradings of 2,879 cases of primary breast cancer at the Mayo Clinic, the frequency with which each grade occurred was as follows: Grade 4 was the designation in 51.3 per cent of the tumors; Grade 3 was the classification into which 33.6 per cent fell; 12.2 per cent were classified as Grade 2, and 2.9 per cent were Grade 1. Comparing his series with our smaller series known to have bone metastases (see Table II), the percentages of each of the grades of the two series runs somewhat analogous. In fact, they are close enough to suggest that the frequency of the occurrence of bone metastases from a particular grade of breast

Table I

CLASSIFICATION OF ALL CASES OF BONE METASTASES BY AGE* ACCORDING TO GRADE OF PRIMARY LESION

Age	Grade 2	Grade 3	Grade 4	Total
39 or less	0	2	6	8
40–55	4	8	9	21
Over 55	2	3	7	12

* At time of mastectomy.

cancer is roughly proportional to the frequency with which that particular grade of malignancy appears in the breast. In other words, if in 10 cancers of the breast 5 were found to be Grade 4, it would then follow that in 10 cases of breast cancer developing bone metastases 5 would be of Grade 4. In view of the fact that there were no cases of bone metastases from Grade 1 cancers in our series, the question arises whether the above theorizing applies to Grade 1 as well, whether metastases to bone ever occur in Grade 1 cancer. To answer this point a list was obtained from Dr. Broders of 2,241 Clinic patients with cancer of the breast which had been microscopically graded by him. Of this number, 64 were graded 1. The histories and follow-up reports on these 64 patients were carefully scrutinized, and in 1 of the 64 patients definite evidence of

Table II

GRADE IN PERCENTAGE OF TUMORS METASTASIZING TO BONE (PRESENT SERIES OF 41) AND OF TUMORS AS FOUND IN THE BREAST (HARRINGTON'S SERIES)

	Present Series	Harrington's Series
	per cent	per cent
Grade 1	0.	2.9
Grade 2	14.6	12.2
Grade 3	31.7	33.6
Grade 4	53.6	51.3

bone metastases was established. This patient had a radical amputation of the left breast on July 6, 1922, for a Grade 1 adenocarcinoma 1.5 by 2 cm. in size. There was glandular involvement Grade 2 (on the basis of Grade 4) in the left axilla at the time of the operation. In December, 1926, she developed pains and subsequently lameness, in the left lower limb, and in March, 1927, a pathological fracture occurred in the upper third of the left femur. Roentgenograms taken at the Clinic showed marked destruction in the proximal end of the left femur, with pathological fracture through the area of destruction. The patient returned to her home city and was given roentgen therapy there. The pain was reported still present following therapy, but lessened in August, 1927. She died a year later in August, 1928, and her attending physician wrote that there was carcinomatous involvement, at the time of her death, of the left trochanter and the whole right side of the bony pelvis.

Thus it is established that bone metastases may occur from any grade of breast cancer, and the inference suggests itself that the various grades of malignancy metastasize to bone in somewhat the same

relative proportion that they bear to each other as they occur in the breast.

Now the question arises, if bone metastases do result as frequently from Grade 2 and Grade 3 malignancies of the breast as from Grade 4 cancer, do they occur as early?

The average time after operation until definite symptoms of bone metastases appeared in the 41 individuals was 22.9 months (Table III). In the 22 cases with Grade 4 tumors, the average corresponding period was 13.6 months, the majority of the group showing definite symptoms within nine months, and 8 of the 22 patients within three months.

In the 13 individuals with Grade 3 carcinomata, symptoms of bone metastases occurred in from seven to forty-seven months postoperatively, with an average time of appearance of 22.9 months for the entire group. The majority showed symptoms in nineteen months or less, but only 3 in less than one year after operation. The average time of appearance of symptoms of bone metastases in patients with Grade 2 cancer was 56.7 months after operation, the individual times for appearance of symptoms in the 6 cases being 27, 28, 47, 65, 85 and 88 months, respectively. In the 1 case of bone metastases from Grade 1 carcinoma of the breast referred to earlier in this paper, it will be recalled that symptoms of metastasis first appeared fifty-four months postoperatively.

The above facts point to the following conclusions: first, in general the lower the grade of malignancy of the primary carcinoma of the breast, the longer the duration of life before metastases to vertebrae or pelvis occur; second, that, specifically, the course of any single case with a graded lesion may vary considerably from that which is the trend of that particular grade as a whole.

This variation in the time of appearance of bone metastases that occurs among individuals having breast lesions of the same grade may possibly be due to factors outside of the tumor itself, and may have to do with the soil on which the malignant seed is sown rather than on the character of the seed itself. The age of the patient, or the physical condition usually coincident with that age, the condition of tissues or of the circulation, undoubtedly are such factors (see Table III). Thus while the average time of occurrence of symptoms of bone metastases in patients with Grade 4 breast cancer is 13.6 months after operation, they occur on an average of 7.4 months postoperatively in the 11 patients under forty-eight years of age, and on an average of 18.7 months in the 11 patients forty-eight years of age or over. Or more strikingly, the time of occurrence of those patients under forty years of age averaged 6.7 months, while in those over sixty years of age it averaged 24.0 months. Similar age relationships exist among the patients with Grade 3 and Grade 2 cancer. The average time of occurrence of symptoms of bone

TABLE III

AVERAGE NUMBER OF MONTHS POSTOPERATIVE BEFORE APPEARANCE OF EVIDENCE OF METASTASES TO SPINE OR PELVIS*

	Grade 4	Grade 3	Grade 2	Total
All ages (41)	13.6 (22)	22.9 (13)	56.7 (6)	22.9
Under 48 (22)	8.6 (11)	19.0 (7)	46.7 (4)	18.8
48 or over (19)	18.7 (11)	27.5 (6)	76.5 (2)	27.5
Extremes of Ages				
Under 40 (8)	6.7 (6)	14.5 (2)	none under 40	8.6
60 or over (5)	24.0 (3)	38.0 (1)	88.0 (1)	39.6

* Number of patients is noted in parenthesis in each case.

metastases in all patients with Grade 3 breast cancer is 22.9 months after operation. In the 7 cases under forty-eight years of age, the average time of occurrence is 19.0 months, in the 6 cases forty-eight years of age or older, it is 27.5 months. In the 2 under forty years of age it is 14.5 months, and in the 1 patient over sixty it was thirty-eight months. In 6 patients with Grade 2 cancer, the average time of occurrence of symptoms of bone metastases is 56.7 months after operation. For the 4 patients under forty-eight years of age this average time is 46.7 months, and for the 2 patients forty-eight years of age or over it is 76.5 months. There were no patients in this group under forty years of age. The youngest one, aged forty, had symptoms of bone metastases twenty-seven months postoperative. The oldest patient in this group was aged sixty years, and did not show evidence to suggest bone metastases until eighty-eight months after the radical amputation of the carcinomatous breast, the longest interval noted in the entire series of 41 cases.

As has been stressed by Harrington, where primary cancers are of the same grade, the prognosis as to life is poorer in those patients with axillary glandular involvement present at the time of the operation than it is in those in whom no evidence of glandular involvement is found. This would lead one to expect to find, in patients with the same grade of primary breast carcinoma, bone metastases occurring earlier as a rule in those individuals in which there was glandular involvement noted in the axilla at the time of the radical amputation of the breast. This proves to be a fact. Gross axillary glandular involvement was noted in 20 of the 22 patients with Grade 4 cancer. In 1 patient there was no involvement found, and in the remaining case there was no note regarding either the presence or absence of such involvement. In the 20 individuals with metastases present in the axillary glands, symptoms of bone metastases occurred on the average of 11.6 months postoperative (see Table IV). In the 1 patient without glandular involvement of the axilla, symptoms of bone metastases did not appear for 21.0 months. Ten patients with Grade 3 cancer had glandular involvement in the axilla at the time of operation. In these 10 cases the average time of appearance of symptoms of bone metastases was 22.4 months postoperative. The other 3 patients with Grade 3 carcinoma presented no glandular metastases at the time of the operation, and developed symptoms of bone metastases on the average of 24.6 months after mastectomy. Of the 6 patients with Grade 2 cancer, 3 presented glandular metastases at operation and 3 did not. In the former the average time of occurrence of evidence of bone metastases was thirty-four months, in the latter 79.3 months. In the case of those without glandular metastases, the time of appearance of symptoms of bone metastases was sixty-five, eighty-five, and eighty-eight months respectively. In the 3 cases with metastases in the axillary glands, the time of appearance of symptoms of osseous involvement was twenty-seven, twenty-

TABLE IV

AVERAGE NUMBER OF MONTHS POSTOPERATIVE BEFORE APPEARANCE OF EVIDENCE OF BONE METASTASES IN PATIENTS WITH AND WITHOUT AXILLARY GLANDULAR INVOLVEMENT AT OPERATION*

	Grade 4	Grade 3	Grade 2	Total
Involvement (33)	11.6 (20)	22.4 (10)	34.0 (3)	16.9
No involvement (7)	21.0 (1)	24.6 (3)	79.3 (3)	47.9
No data (1)	48.0 (1)			

* Number of patients is noted in parenthesis in each instance.

eight, and forty-seven months postoperative. It has been the policy of the surgeons and pathologists at the Mayo Clinic for a number of years to grade the degree of axillary glandular involvement from I to IV, grade I representing slight, minimal involvement, grade IV, extensive involvement, and grades II and III intermediate degrees of gross glandular metastatic involvement. In the patient with the Grade 2 carcinoma who went forty-seven months after operation before the appearance of symptoms of metastatic bone lesions, the glandular involvement at the time of operation was grade I, or slight. In the other 2 cases with Grade 2 carcinoma, who went twenty-seven and twenty-eight months before indications of bone metastases, the glandular involvement was grade III (see Table V). Of the 10 patients with Grade 3 carcinoma and coincident axillary glandular involvement, the involvement of the axilla was grade IV in 2 instances, grade III in 2 instances, grade II in 5, and grade I in one. In the 20 similar patients with Grade 4 carcinoma the glandular involvement of the axilla was grade IV in 13, grade III in 2, grade II in 3, and grade I in the remaining 2 cases. It would appear that in general, while knowledge of the grade of the breast tumor is of utmost importance in the prognosis regarding occurrence of bone metastases, the degree of metastases evident in the axillary glands at the time of operation is a consideration of some secondary significance.

The location and number of the metastatic bone lesions apparently bear no relation to grade of malignancy. They were multiple in approximately two-thirds of the cases of each group. Metastases were equally as common in the spine as in the pelvis, more common in the lower dorsal and lumbar spine, and in the ilia than in the upper spine or other pelvic bones. The tenth dorsal vertebra was by far the most frequently involved vertebra, regardless of the grade of the primary cancer. Involvement of this vertebra was noted in 9 instances.

TABLE V

DEGREE OF GLANDULAR INVOLVEMENT AT TIME OF OPERATION OF THE PATIENTS LATER HAVING BONE METASTASES

Cases	Degree of Involvement				
	Grade IV	Grade III	Grade II	Grade I	None
Grade 4*	13	2	3	2	1
Grade 3	2	2	5	1	3
Grade 2	0	2	0	1	3

* No data obtained in 1 case.

The location of the pain, which was present in all cases prior to radiotherapy, bore a fair relationship to the location of the bone metastases as shown in the roentgenogram. The almost typical story was that of pain in the lower back, present for varying intervals of time, increasing in severity, greatly aggravated by motion, unrelieved by aspirin and similar preparations, and eventually forcing the individual to bed and partial, if not actual, invalidism. Often morphine was required, and this was usually of only transitory value in mitigating pain. Pain near the hips, with radiation into either thigh, was frequently noted. Low dorsal pain, with radiation along one or both costal borders, occurred in several instances. Pain was occasionally intermittent at the start, present when the patient was active and about, and absent when the patient rested, but in a matter of weeks the pain usually became persistent. The onset at times, however, was acute, with sudden severe pain occurring following some trivial action, such as rising from a chair. Of frequent occurrence was pain arising from one

area of involvement, such as root pain referable to the level of a specifically involved dorsal vertebra, with simultaneous roentgenologic demonstration of the presence of many more areas of metastases throughout the spine and pelvis, none of which were producing symptoms. Indeed this was the rule rather than the exception. In 1 case the only pain was dorsal in location, and the roentgenogram of the dorsal spine was negative for metastases, while the pelvis and lower lumbar spine showed multiple metastases. This case is a good illustration of the statement by Sutherland, Decker and Cilley, that "we have seen at necropsy extensive involvement of the bodies of the vertebrae by metastatic carcinoma, without enough alteration in density or structural form to allow of a definite roentgenologic interpretation of metastasis." There was no apparent relationship demonstrable between the location and type of pain present and the grade of the primary carcinoma in the 41 cases.

Diagnosis in these 41 cases was established by following the precepts set down under the discussion of diagnosis earlier in this paper. In 1 case the diagnosis was established by the occurrence of a fractured femur sustained while alighting at the curb from a taxi. Roentgenograms revealed that it was a pathologic fracture, and established the presence of additional metastatic areas in the pelvis.

The great majority of metastases, as revealed by the roentgenogram before roentgen therapy, were predominantly of an osteoclastic nature. In a few (three), there was a fair amount of osteoplasia present along with the destruction. Although roentgenograms following roentgen therapy were available in only a limited number of cases, in 4 individuals (1 patient with Grade 4 primary lesion, 2 patients with Grade 3 primary carcinoma, and 1 patient with Grade 2 carcinoma) there was striking evidence of repair, with the laying down of new bone, following treatment. In several additional cases there was noted a slight increase in the relative amount of osteoplasia, but this was not marked. It has been stated[64] that a comparison of the types of metastases in cases of carcinoma of the breast showed the osteoclastic, purely destructive type predominating in carcinomas graded 4, whereas among carcinomas of lower grade of malignancy there is an increased tendency toward the mixed osteoclastic and osteoplastic types. This statement is not borne out by a study of the roentgenograms available in this series of cases. In the roentgenograms of all patients with Grade 2 carcinoma the metastases were obviously osteoclastic. As has been said before, the only pre-treatment roentgenograms showing moderate evidence of osteoplasia mixed with the osteoclasia were in 2 patients with Grade 3 carcinoma and 1 patient with Grade 4 carcinoma. After treatment, evidence of osteoplasia was as apt to be seen in one grade as another. In each case showing striking evidence of repair, the patient was living twenty or more months after the first roentgen treatment.

Convinced of the lack of relationship between the grade of the primary tumor and the roentgen appearance of secondary bone metastases, we chose numerous roentgenograms of bone metastases at random from among the cases of this series, but including roentgenograms of all grades, and we submitted them to one of the members of the Section of Diagnostic Roentgenology at the Mayo Clinic, and later to another member of the same section, and to a member of the Section on Radiotherapy. They were asked to try to pick out the Grade 2, the Grade 3 and the Grade 4 metastases on the basis of roentgenologic appearance. As the only conceivably logical basis for classification depended on the assumption that the more osteoplasia present, the more apt were the metastases to be from a low grade malignancy, the selections of these radiologists were as often wrong as right, and they were unanimously of the opinion that it is not possible to determine the grade of malignancy of the primary lesion on the basis of the character of the roentgenological appearance of the osseous metastases from it.

While this paper is not concerned with a discussion of the value of roentgen therapy applied to the thorax directly postoperative, during convalescence, it is of interest that 35 of the 41 patients had had the benefit of such treatment in some form or other, 22 having had three or more "courses" of treatment, 7 more having had two treatments each. As Leddy states, "It is self-evident that roentgen therapy directed to the thorax in postoperative treatment can have no effect on malignant cells already disseminated outside the fields treated, and that it is of no avail in slowing the growth of those cells already in the spinal column and pelvic bones. Sufficient evidence has not yet been accumulated to justify 'prophylactic treatment' of the spinal column as routine in addition to that of other danger zones. However, from the standpoint of safety alone, the possibility is worth consideration." In at least 2 instances in this series, symptoms of bone metastases appeared during the period of postoperative roentgen therapy to the thorax, obviously illustrating the points made by Leddy.

TREATMENT

The status of treatment of bone metastases before the advent of modern roentgen therapeutic methods is characteristically summarized in an article by Osler[51] in 1906. In this he writes that "Scarcely enough stress is laid in works of surgery upon the terminal stages of cancer, with the tragic events of which the general practitioner is left to battle alone . . . . The most common and the most serious, as entailing a maximum of suffering, are the lesions of the spine. . . . Amid the sad failures of our art, these cases stand out in strong relief. An early diagnosis of the condition (bone metastases), and an early recognition of the hopelessness, may lessen the terrible ordeal of the poor victim and mitigate not only her suffering, but those of the near relatives. MORPHINE, enough MORPHINE! given freely and without fear, in doses sufficient to keep the patient comfortable, AFFORDS THE ONLY POSSIBLE RELIEF." Even as late as 1915, Matthews,[48] after an extensive review of the literature on metastatic carcinoma in bone, writes: "I can find no mention of X-ray or radium treatment in these cases," and offers no additional therapeutic advice to that given above by Osler. Various methods of symptomatic treatment by casts, braces, laminectomy, epidural injection of the sciatic nerve, ramisectomy and even chordotomy, have been tried, but the results have been discouraging in all but a few instances, and many of these procedures were applicable in only very selected cases.

In 1907, Freund[21] reported roentgen treatment of a patient with probable metastasis to the pelvis from carcinoma of the breast. This was undoubtedly the first such case reported in the literature, and apparently did not come to the attention of Matthews in his survey. The next report did not appear until 1917, that of Levin,[47] noting marked improvement in a patient with bone metastases, following irradiation of the metastatic area. Two years later there appeared a paper by Pfahler,[53] reporting 4 cases in which patients were made more comfortable by roentgen therapy, and in which life was thought to have been prolonged. He noted recalcification occurring in metastatic areas following treatment. In a later paper he reported the duration of life in 1 case for four years after therapy, the patient finally dying from visceral metastases. He favored moderate dosage of high voltage through many portals. Since this paper appeared, there have been frequent reports, mostly of the same nature, in the literature. Jenkinson,[38] in 1924, reported 3 patients alive after three years and comparatively free of pain. He stated: "To see a patient bedridden and completely paralyzed from the waist down, with no control of the urine or bowels, get up and walk after a course of treatment, is, to say the least, gratifying." He used high voltage roentgen rays, heavily filtered, in moderate doses. Beck[2] in 1924 added a case to those of Pfahler, in which there was complete restoration of the upper ramus

of the pubis on the right side after it had been destroyed by a metastatic growth from the breast. Giles,[23] Holmes,[36] Joly,[39] Lemaitre,[45] Jacobs,[37] Holfelder,[35] Borak,[6] Schlesinger,[61] Lee and Herendeen,[43] Pancoast,[52] Grier,[28] and Ginsburg[25] have reported frequent improvement following treatment by roentgen rays. Of more recent date are the excellent and comprehensive reports of series of such cases by Leddy in 1929, Geschickter and Copeland in 1931, Lenz and Freid in 1931, and Stenstrom and Ericksen in 1932. Papers in 1927 by Desjardins and by Borak in 1930 discuss well the analgesic property of roentgen rays, the latter particularly with regard to their effects on bone metastases. Borak states that roentgen rays can influence solely a pain that has arisen under pathologic conditions, that they act as an analgesic only when they act therapeutically, that they act as an analgesic only so long and only to the extent that they exert healing effects. Drug analgesics such as morphine afford immediate relief for a very limited time. This relief is symptomatic only, through influencing the pain transmitting, nerve conduction mechanism, or through influencing the cerebral pain centers. The effects of roentgen rays in bone metastases never become evident within a few minutes, but only after a lapse of several hours at the earliest, and usually after several days, and often after a period of several weeks,—and continue, even though they may be of a transitory nature, not only a few minutes or hours, but at least for several days and usually several weeks —often several years; or the pain may be relieved permanently. Partial or complete, transient or permanent relief of pain occurs, says Borak, only so far as there is partial or complete, transient or permanent retrogression of the pain producing pathologic process, independent of its nature. Desjardins has stated that there is reason to believe that the relief from pain is due to the release of sensory nerves from pressure by the tumor, although it is conceivable "that nerve cells, which, of all the cells in the body are the most resistant to irradiation so far as functional or organic damage is concerned, are acted on in a specific manner, and their irritability diminished by irradiation." As has been mentioned earlier in this paper, Kaufmann and others have observed a zone of inflammation at the periphery of metastatic lesions in bone. Desjardins has said that in irradiation of lymphocytes in general, an effect is perceptible microscopically as early as three hours after exposure. Inasmuch as lymphocytes constitute a large proportion of this inflammatory zone, it is possible that the destruction of such lymphocytes by irradiation may so relieve pressure on adjacent sensory nerves as to remove the chief cause of pain. Leddy feels that this destruction of the inflammatory tissue probably explains the onset of analgesia where it occurs within the first week after treatment, the effect on the carcinoma itself appearing after more than a week. This effect on inflammatory tissue can occur with dosage insufficient to have much influence on carcinoma tissue itself, and Borak suggests that ofttimes relief is only temporary and palliative because it was sufficient to eliminate the immediate cause, the secondary inflammatory filtrate, but not the ultimate cause of the pain, the carcinoma cells themselves. Where relief is of long duration there is probably destruction within the tumor, with some retrogression. Inasmuch as metastases to bones in themselves do not involve organs absolutely essential to life, and as the condition in the bones, with the associated pain, may persist indefinitely until vital organs are attacked or secondary complications have ensued, such as pneumonia, relief such as afforded by roentgen therapy is well justified, and, as Borak states, fills the same rôle as digitalis in decompensated hearts or decompressions in inoperable brain tumor cases.

The average case in the present series first received roentgen treatment 4.4 months after symptoms of bone metastases had appeared. Some received treatment

within a week or two of the onset of pain, and 1 case did not receive treatment until twenty-one months after the first appearance of symptoms indicative of metastasis which was later confirmed by roentgenograms. This latter case was the only one of the series to go more than one year, after definite symptoms had presented themselves, before receiving roentgen therapy. The average time of coming to treatment after occurrence of symptoms varied little with the grade of the primary tumor from which the metastases occurred, being 5.2 months for the Grade 2 group, five months for the Grade 3 group, and slightly earlier, 3.9 months, for the Grade 4 group. Delay in coming to treatment was attributable to various causes such as the mildness and variability of the pain at the onset, misinterpretation of the symptoms, unawareness of what roentgen therapy had to offer in the way of analgesia, or because roentgenograms of the painful areas were negative at first. Frequently the delay was due to economic circumstances, the patient being unable or unwilling to seek aid. Several patients had sought relief through chiropractic adjustments and 2 cases from osteopathic manipulation. Another was treated for rheumatism with typhoid vaccine, and in 1 case tonsillectomy was performed without benefit. Another unsuccessfully sought relief by taking baths at a well known spa.

Treatment was given in all cases primarily for the analgesic action of the roentgen ray, and more than palliation was not expected. By the time dissemination of the cancer is widespread enough to produce gross evidence of bone involvement at some distance from the site of the primary lesion, the possibility of stemming the fatal tide through local treatment to isolated metastatic regions in indeed remote, although it can happen.[24]

The technique of treatment varied in different cases, but was generally as follows: Cross firing in the pelvis through four large fields (one anterior, one posterior, and two opposite lateral fields) at high voltage; cross firing of the spine at moderate voltage, through large fields on each side of it, the beams converging at an angle of about 45 degrees. High voltage factors consisted of 200 kv., 5 ma., 50 cm. target-skin distance, 0.75 mm. copper and 1.0 mm. aluminum filters, with an exposure time from 60 to 70 minutes (approximately 550 r. measured in air). Moderate voltage consisted of 135 kv., 5 ma., 40 cm. target-skin distance, 6.0 mm. aluminum filter with an exposure time of 25 to 28 minutes (approximately 500 r, measured in air). In later treatments to the same areas the exposure time was frequently reduced. The treatment had to be given slowly in order to avoid severe reaction. One field daily was usually well tolerated.

The analgesic response to treatment was classified under four divisions: (1) complete *relief*, which heading is self explanatory, meaning just as it implies, complete relief of pain following roentgen treatment, coming on immediately or within several weeks of treatment, and lasting an interval of weeks, months or years; (2) *considerable relief*, under which heading are listed those cases in which there was a very marked improvement, often meaning the returning of a bed-ridden, suffering patient to a more normal and satisfactory existence, but in which the relief was not complete, some residual ache or pain persisting, though of relatively minor nature; (3) *partial relief*, in which were put those cases receiving some distinct amelioration of symptoms but not sufficient to justify classification under *considerable relief;* and (4) *no relief*, into which classification were put those cases deriving no benefit from therapy and those cases whose reports after treatment were too indefinite to be certain that any improvement had taken place.

In the 41 patients of the present study treated for relief of pain, definite analgesia was obtained in 35, or 85.3 per cent. In 6 there was no relief. In 29, or 70.7 per cent, of the 41 cases the relief was considerable or complete, and in 14, or 34.1 per cent, it was complete. The type of response to

treatment according to the grading of the primary tumor responsible for the metastasis is shown in Table VI. In each of the three grades studied, a high degree of relief ranging from considerable to complete occurred in the great majority of cases. There is a suggestion that complete relief was of relatively more frequent occurrence in the lower grades than in Grade 4 metastases. On the other hand, there were failures to obtain relief in each of the groups. In general the conclusion must be drawn that the results, according to grade of malignancy, are not enough different to justify the statement that initial relief of some degree can be obtained much more readily in any one grade of malignancy than in another. The pertinent subject of "the duration of relief," however, of which nothing has been said as yet, will appear in the discussion later.

In approximately a third of the cases of *each grade* of malignancy it was noted that improvement began "before completion of the full course" or "within a few days to a week after completion of course." In the remainder the improvement was of gradual onset, occurring within one to four weeks where checked carefully. Maximum improvement obtained from any course of treatment was reached in all instances within one month of the completion of treatment, except in 1 case, a patient with metastasis from a Grade 2 carcinoma, whose response to treatment was more gradual. In this individual, relief of pain occurred gradually over a period of six weeks following a single course of treatment, becoming complete at that time. It is further of interest in this particular case that, with no further treatment, the patient was to all appearances completely well and without recurrence of pain for twenty-four months. The pain was the slowest to disappear and in turn the slowest to re-appear, following a single course of treatment, of any of the 41 cases. It has been observed in the Department of Roentgen Therapy at the Mayo Clinic, in the case of lymphoblastoma, that the more rapid the roentgen therapeutic response, in general, the more "malignant" the disease, and the earlier the recurrence; the slower the response to roentgen therapy the slower the course of the disease, and the slower to recur. It is suggested that there may be considerable analogy between this response and that of the case reported above.

TABLE VI

TYPE OF PAIN RELIEF OBTAINED BY ROENTGEN THERAPY

	Complete	Considerable	Partial	No Relief
Grade 4 (22 cases)	5	9	4	4
Grade 3 (13 cases)	7	3	2	1
Grade 2 (6 cases)	2	3	0	1
Total (41 cases)	14	15	6	6
Total in percentage	34.1	36.5	14.6	14.6

Knowledge as to the benefit, it any, of giving the treatment early in the disease, soon after the appearance of symptoms of metastases, is of obvious interest. In Table VII the relationship of time of treatment to type of relief obtained is shown.

Patients, 35 in all, obtaining relief of one type or another came to treatment in an average of 3 to 4.5 months after onset of symptoms, and whether the treatment afforded partial, considerable or complete relief, the average duration of symptoms before treatment was approximately the same. Whether the patient had metastases from a Grade 4, Grade 3, or Grade 2 carcinoma of the breast made no difference, the average time of coming to treatment was approximately the same for those of each grade obtaining complete relief, for those obtaining considerable relief, and for those obtaining only partial benefit. The 35 individual cases obtaining relief came to treatment within two weeks to ten months, 32, or 91.4 per cent, receiving treatment within eight months or less. The 1 patient coming to treatment ten months after the onset of symptoms and still obtaining relief had a Grade 2 malignancy and obtained considerable relief of twelve months'

duration. The other 2 patients coming to treatment after more than eight months and obtaining relief had metastases from a Grade 4 malignancy. One patient after nine months received considerable relief for three months following one course, with considerable relief for three months from a second course given after recurrence of pain. The other obtained complete relief for five months from one course of treatment given nine months after evidence of metastases had occurred, and received considerable relief for thirteen more months from subsequent treatment.

exceeding by twelve months the similar period of any other patient in the entire group. Thus, 3, or 50 per cent, of the 6 cases obtaining no relief did not receive treatment until eleven to twenty-one months after the appearance of evidence of metastatic bone lesions, the only 3 patients of the entire 41 to go that long without roentgen therapy to the areas of bone involvement. Explanation of the failure to obtain relief in the other 3 cases apparently lies in another direction.

It would appear from the above facts that while likelihood of obtaining relief or

Table VII

AVERAGE TIME INTERVAL (IN MONTHS) BETWEEN FIRST SYMPTOMS OF BONE METASTASES AND SUBSEQUENT ROENTGEN THERAPY OF PATIENTS OBTAINING THE VARIOUS TYPES OF RELIEF

Group	Complete Relief	Considerable Relief	Partial Relief	No Relief
Grade 4 (22 cases)	3.0 (5 cases)	3.9 (9 cases)	3.2 (4 cases)	7.0 (4 cases)
Grade 3 (13 cases)	4.5 (7 cases)	4.0 (3 cases)	4.5 (2 cases)	12.0 (1 case)
Grade 2 (6 cases)	4.5 (2 cases)	3.8 (2 cases)	No Cases	11.0 (1 case)
Total all groups	4.0 (14 cases)	3.8 (15 cases)	3.6 (6 cases)	8.5 (6 cases)

The 6 patients obtaining no relief from roentgen therapy came for treatment at an average time of 8.5 months (Table VII) after onset of symptoms of bone metastases. This average time is in striking contrast to that of the 35 obtaining relief, and the contrast holds within each group of malignancies. The only case failing to respond to treatment in the Grade 2 group was the case in that group having definite symptoms of metastasis for the longest interval of time, eleven months, before receiving roentgen therapy. Similarly, the 1 patient in the Grade 3 group receiving no relief had gone twelve months before receiving treatment, longer by four months than any other case in the group. The 4 patients in the Grade 4 group receiving no benefit from therapy came to therapy after symptoms for periods of one, two, four and twenty-one months, respectively, the latter

palliation following roentgen therapy is considerable if given within eight months, the prospects diminish rapidly after this lapse of time. The type of relief afforded at any time within this period may vary in degree from partial to complete, independent of whether it is given immediately or not until four to eight months after the onset of symptoms.

The duration of the relief, once it is obtained, is of prime consideration to all concerned. Complete relief as obtained in the 5 patients with bone metastases from Grade 4 carcinoma varied in duration from one and a half to ten months (Table VIII).

Case 41 received complete relief from bilateral lumbosacral backache with bilateral sciatic radiation from one course of treatment, and there was no recurrence up to the time of her death one and a half months later from pneumonia complicating

extensive pulmonary metastases. At autopsy, in addition to the vertebral, pelvic and pulmonary involvement, there were metastases to stomach, adrenals, and abdominal lymph nodes, and there were recurrent nodules in the skin of the breast.

Case 32 received complete relief from crippling upper sacral pain for 2.5 months, with occasional recurrent twinges most of the remainder of the year following, and was again "suffering some" by the end of the year.

Case 34 received complete relief of pain in left hip region with radiation down left thigh, for five months, with almost complete relief for seven more months following further treatment, and considerable further relief for four more months; "very comfortable" when last heard from. Roentgenograms after treatment show unusual evidence of bone repair.

Case 26 received complete relief for eight months of right sacroiliac pain radiating into thighs, a second course being given four months after first. There was gradual recurrence with death twelve months after first treatment.

Case 29 received treatment to the dorsal spine over two areas without relief in three weeks, of a pain in this area radiating around right lower costal margin. At time of second visit three weeks later, a second course afforded complete relief which had persisted ten months at last report.

Complete relief of pain, as obtained in 7 patients with bone metastases from Grade 3 carcinoma, varied from two to thirty-one months, 1 of the patients being still alive

TABLE VIII

TYPE OF RELIEF AND DURATION OF RELIEF IN MONTHS FOLLOWING ROENTGEN THERAPY

Case No.	Complete Relief	Considerable Relief	Partial Relief
		GRADE 2	
12	24	7* and 3**	
14		12	
20		4 and 2*	
28	Treatment afforded no relief		
30	No relief from 1st course	1½ (2nd course)	** and *** uncertain duration
31	6	3* (3rd course given during this period)	
		GRADE 3	
2	6	* (given elsewhere) Duration?	
4	18		* (3 mo. after recurrence)
5		18	*
8	2	6* (2 courses given)	
9	18 (2nd course 6 mo. after 1st)		
	9*		**
16	Treatment afforded no relief		
17	31 (4 courses given)		
18	2		
21		2 (until death)	
35			3 (2 courses)
37	18 (without recurrence to date)		
38			1½ plus
39		2	
		24* (several courses)	

TABLE VIII (*continued*)

TYPE OF RELIEF AND DURATION OF RELIEF IN MONTHS FOLLOWING ROENTGEN THERAPY

Case No.	Complete Relief	Considerable Relief	Partial Relief
		GRADE 4	
1			½ plus (duration unknown)
3			2
6		1 and 2*	
7			2
10		5 (3 courses)	2 plus* (2 courses)
11	Treatment afforded no relief		
13	Treatment afforded no relief		
15		6 (2 courses)	* (2 courses) (short duration)
19		½*	½
22		3 and 3*	
23		29 (3 courses—almost complete relief to date)	
24		1½	
25		7½ plus	
26	8 (2 courses)		
27	Treatment afforded no relief		
29	10 plus (2 courses—no relief for 3 wk. after 1st)		
32	2 plus		
33		½ plus	
34	5	7* (2 courses)	
		4 plus**	
38	Treatment afforded no relief		
40		7 (2 courses)	
41	1½ (until death from pulmonary complications)		

Single asterisk indicates result of additional treatment given after recurrence or exacerbation of pain, two asterisks indicate result of a further course of treatment given after a second exacerbation, etc.

and free from symptoms.

Case 18 within several days obtained complete relief for two months from severe pain in lower back and across hips, remained very comfortable for several more months and then had a gradual return of pain.

Case 8 received complete relief for two months from pain radiating from left ilium into left thigh. Patient returned one year after first treatment with pain severe again and metastases to all lumbar and lower, dorsal vertebrae, pelvis, skull, mandible, femurs, clavicles, scapulae, ribs and humeri at this time. A second course of treatment to entire spine and pelvis furnished considerable relief for three more months, with recurrence of pain in a new area from which a third course of therapy furnished considerable relief for nearly six months. Pain never returned to a severe degree prior to death twenty-eight months after first roentgen treatment.

Case 2. A steady lumbar ache radiating into both thighs was completely relieved following moderate voltage roentgen therapy to lumbar back. Pain was much less even by end of course of treatment. Pain developing in right hip six months later was treated elsewhere with considerable relief reported.

Cases 4, 9, and 37 were all completely re-

lieved of pain for eighteen months. Case 4 was partially relieved for three more months following recurrence. Case 9 obtained nine more months of complete relief and further partial relief, living thirty-nine months after first treatment for severe lumbar pain. Case 37 was relieved within a few days of pain radiating around the right costal margin, and was still free from pain at examination eighteen months later, although metastases appeared more extensive in the roentgenogram than before.

Case 17. Severe lower dorsal backache was relieved completely for thirty-one months by one course of treatment, followed by others at three, eight and twelve months. Patient eventually died of lung complications.

Complete relief of pain was obtained in 2 patients with metastases from Grade 2 carcinoma for periods of six and twenty-four months respectively.

Case 31 received treatment for low lumbar pain radiating into left hip and thigh. Marked improvement was felt by end of course of treatment (five days), and pain was entirely gone within a month, not recurring until six months later, this time with radiation into the right thigh. Repetition of treatment brought considerable relief, lasting until death four months later following a "sudden going to pieces" in which dyspnea and cough were prominent.

Case 13, with ache in lower back and pain running down into both lower extremities, obtained gradual relief, becoming complete in six weeks, following one course of treatment, and remained symptom free for two years. Recurrence of pain was relieved seven months more by a second treatment, and three months further much relief was afforded by a third treatment given after a second recurrence. Fourth treatment after a third recurrence gave little relief, and patient died forty-five months after first course of therapy, in considerable pain prior to death.

Considerable relief was obtained for periods of one to seven and a half months in 8 of the 22 cases with bone metastases from grade 4 carcinoma. In an additional case there has been twenty-nine months (at last report) of almost complete relief from pain. In some of these cases where further treatment was given following recurrence of the pain, additional relief of the same type was obtained, but usually for a lesser period.

Considerable relief of two, three and eighteen months, respectively, was recorded in 3 cases of the Grade 3 group. In the first case this persisted till death; in the second a recurrence was considerably relieved for two more years by repeated treatment, and in the third partial relief was obtained by later treatment following recurrence.

In the Grade 2 group considerable relief was obtained in 3 cases for one and a half, four and twelve months respectively, with added relief from later treatments for shorter periods.

Duration of the partial relief as reported in 4 cases of the Grade 4 group and 2 cases of the Grade 3 group was difficult to evaluate with any definiteness because of the gradual blending of the relief period into the period of increasing, returning pain. In most instances it seemed to extend from several weeks to three or four months.

Where so much varied response occurs, comparison is not easy. However, one-third (2 out of 6) of the Grade 2 group received complete relief for periods of six or more months from single courses of treatment, 5 of the 13 in Grade 3 received similar relief (2 receiving more than one course), while of the 22 in the Grade 4 group, only 2 received complete relief for six months or more, each receiving two courses of treatment. It seems, therefore, that although any type and duration of relief from treatment can occur in cases of any group, the more favorable responses in point of degree and duration will be seen more often among patients with the lower grade malignancies.

An interesting group are the 6 cases obtaining no relief. Possible explanations of reasons for failure are suggested in a review of their histories. As has been mentioned

earlier in the paper, 3 of these, Case 28 (Grade 2), Case 16 (Grade 3), and Case 27 (Grade 4), did not come for treatment until eleven, twelve and twenty-one months, respectively, after the occurrence of symptoms of bone metastases. This delay in receiving treatment undoubtedly was an important factor in determining its result, irreparable radioresistant changes having occurred by the time roentgen treatment was attempted.

Case 28 complained of pain in right hip region, radiation into the limb, and had roentgen evidence of metastasis in the right sacroiliac area. Two treatments with high voltage roentgen therapy were given to the pelvis, front and back, instead of the usual four treatments. It is possible that an additional course of treatment or four full fields might have offered her relief not obtained from her original treatment.

Case 16 likewise received only modified treatment, moderate voltage, three fields over the dorsal, lumbar and pelvic regions, respectively, of the back, for pain between the scapulae and in the lower back. There was roentgen evidence of multiple metastases throughout the spine and near the left sacroiliac region of the pelvis.

Case 27 had root type of pains running into the lower abdomen and into the lower extremities, with roentgenographic evidence of metastases to lumbar spine and pelvis. Here again, only moderate voltage roentgen therapy was used, and to four fields on the mid and lower back.

The 3 other cases obtaining no relief were all of the Grade 4 group. In 1 of these, Case 11, a modification of treatment similar to that in Cases 27, 16 and 28 was used instead of the usual technique. Case 13 had low backache and destruction of the fourth lumbar vertebra and received the usual lumbar spine technique but no treatment to the pelvis. It is possible that the origin of pain may not have been from the fourth lumbar area, but a lower, yet undemonstrable area in the untreated pelvis.

Case 36, the remaining case, received full treatment to lumbar spine and pelvis when metastatic pain in the low back appeared when returning for her third course of postoperative roentgen therapy to the thorax. There was no relief from pain during the course of treatment, and the only report two months later said patient was losing weight and strength and felt poorly. The case was classified as no relief, though it is possible partial relief may have occurred.

The history of these failures seems to point to the advisability of treating early and treating adequately. Where the site of the trouble may be deep seated as in the pelvis, it would appear that multiple beams of the more deeply penetrating, high voltage origin directed to it from a minimum of four angles is the treatment of choice, and offers the best chance of palliation. Likewise, from the experience in several cases in the series, it seems decidedly worth while to repeat a course of treatment after an interval of three or four weeks if the pain persists and there is strong reason to suspect a metastatic origin.

While much more than palliation of pain is not expected, there are many instances in which there is undoubtedly a prolongation of life, a return at times for months from a semimoribund condition. Meyerding, Carman and Garvin,[49] reporting more than ten years ago a series of cases with metastases to the bones from carcinoma of the breast, stated that the average duration of life after discovery of the bone metastases was 4.7 months (25 cases). In our group, already dead, are 29 cases living for an average of 15.5 months following the first roentgen treatment for bone metastases (Table IX). Allowing to some extent for possible earlier recognition of bone metastases now than at the period of their paper, it would still appear that there is a longer duration of life in the present group, probably, at least partially, related to the roentgen therapy received.

From Table IX it can be seen that the average duration of life following treatment is greater in the Grade 2 group than in the Grade 3 group, and decidedly greater in the Grade 3 group than in the Grade 4 group.

Whether the duration of life, longer in the Grade 2 than in other groups, is entirely due to inherent characteristics of the tumor, or in part because Grade 2 metastases are more permanently affected by roentgen therapy cannot be answered at this time. It can be stated, however, that because patients with Grade 2 and Grade 3 malignancies appear to live longer after metastases to bone have occurred, relief of pain during this interval is of even more importance than in the higher grade, more rapidly fatal malignancy. Furthermore, as has been stated before, the more favorable responses to therapy occur more frequently and more repeatedly in just these cases.

Table IX

AVERAGE DURATION OF LIFE (IN MONTHS) AFTER ROENTGEN THERAPY*

	Grade 4	Grade 3	Grade 2	All Grades
Those now deceased	14.9 (15)	20.7 (8)	22.3 (6)	15.5 (29)
Range	2–24	3–38	10.5–45	2–45
Those still living	12.6 (7)	18.4 (5)	None	15.0 (12)

* Number of patients is given in parenthesis in each instance.

SUMMARY

It is realized that this series of 41 cases of bone metastases from carcinoma of the breast is small from which to draw conclusions. It is, however, to date, the largest series of this nature available, and, as far as could be ascertained, the only series of its kind in which classification of malignancy according to Broders was used, and in which there were complete data in every case from the time of the original operation on the breast to the finally reported result of the roentgen therapy given to the bone metastases. In view of these facts the following statements based on the foregoing data appear warranted:

1. The higher the grade of malignancy of the breast cancer, the earlier the appearance of bone metastases.

2. In breast cancer of the same grade: A. The younger the individual, the earlier the osseous metastases. B. The greater the degree of axillary glandular metastases found at operation, the earlier the appearance of metastatic bone lesions.

3. Location or number of metastases bore no relation to grade of malignancy.

4. Roentgenographic appearance of metastatic areas was similar regardless of grade.

5. Roentgenographic evidence of recalcification after treatment was seen in bone lesions of all grades.

6. There was an average of 4.4 months' delay before the average individual received roentgen therapy after symptoms of bone metastases had appeared.

7. Although the higher degrees of relief from roentgen therapy were somewhat more frequent in the Grade 2 and Grade 3 groups than in the Grade 4 group, the likelihood of obtaining some degree of initial relief was about as great in one group as another.

8. The more favorable response to roentgen therapy, in point of both type and duration of relief, was seen to a greater extent among patients with the lower grades of malignancies.

9. Relief in some degree from roentgen treatment was obtained in 35 out of 38 patients coming to treatment within ten months of the onset of symptoms of bone metastases.

10. No relief was obtained from roentgen therapy in any of the three (one from each of the Grade 2, 3 and 4 groups) coming to treatment after a lapse of more than ten months.

11. It is suggested that in the treatment of the pelvic region multiple beams of high voltage radiation directed to it from a minimum of four angles offers the best chance of palliation.

12. The lower the grade of malignancy, the longer the duration of life after the occurrence of bone metastases and after their roentgen treatment.

13. Although palliation was all that was expected, there was undoubtedly prolongation of life in certain individual cases.

14. While many of the above inferences appear true for the various groups of cases considered in toto, it must be re-emphasized that exceptions were not infrequent.

CONCLUSION

The course of bone metastases from carcinoma of the breast is, for the most part, similar to the course of the tumor in general throughout the body. The less malignant the tumor, the longer the delay in the appearance of bone metastases, and the longer the duration of life after they once appear. In general, the less malignant the tumor of the breast, the greater the relief of pain obtained from roentgen therapy of its secondary bone lesions, and the longer the remissions of pain so induced.

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REFERENCES

1. Askanazy. Quoted by Downs and Hastings.[17]
2. Beck, E. G. Cancer therapy from the surgeon's standpoint. Am. J. Roentgenol. & Rad. Therapy, 1924, *11*, 117–137.
3. Borak. J. Röntgenbehandlung metastatischer Knochengeschwülste. *Arch. f. klin. Chir.*, 1926, *143*, 185–199.
4. Borak, J. Röntgenbehandlung von Knochenkarzinommetastasen. *Wien. klin. Wchnshr.*, 1926, *39*, 611.
5. Borak, J. Röntgenbehandlung metastatischer Knochengeschwülste. *Forstchr. a. d. Geb. d. Röntgenstrahlen*, 1927, *Kongresshft*, *17*, 33–34.
6. Borak, J. Analgesic effects of roentgen rays, with especial consideration of bone metastases of cancer. *Radiology*, 1930, *14*, 328–338.
7. Broders, A. C. *Ann. Surg.*, 1921, *73*, 141–160.
8. Broders, A. C. Grading of carcinoma. *Minnesota Med.*, 1925, *8*, 726–730.
9. Broders, A. C. Grading of cancer; its relationship to metastasis and prognosis. *Texas State J. Med.*, 1933, *29*, 520–525.
10. Carnett, J. B. Scirrhous carcinoma of the breast with extensive metastases. *Surg. Clin. North America*, 1927, *7*, 7–30.
11. Carnett, J. B., and Howell, J. C. Bone metastases in cancer of breast. *Ann. Surg.*, 1930, *91*, 811–832.
12. Cave, P. Osteoplastic metastases. *Brit. J. Radiol.*, 1933, *6*, 69–84.
13. Copeland, M. M. Skeletal metastases arising from carcinoma and from sarcoma. *Arch. Surg.*, 1931, *23*, 581–654.
14. Copeland, M. M. Bone metastases; study of 334 cases. *Radiology*, 1931, *16*, 198–210.
15. Desjardins, A. U. Analgesic property of roentgen rays. *Radiology*, 1927, *8*, 317–324.
16. Downs, E. E. Bone metastasis in breast cancer. *J. Med. Soc. New Jersey*, 1932, *29*, 957–958.
17. Downs, E. E., and Hastings, W. S. Factors influencing the types of metastatic carcinoma of bone. Am. J. Roentgenol. & Rad. Therapy, 1933, *29*, 1–7.
18. Downs, E. E., and Hastings, W. S. Observation in preliminary study of tumor histology and bone metastases. *Radiology*, 1933, *21*, 76–78.
19. Ewing, J. Neoplastic Diseases. Third edition. W. B. Saunders Co., Philadelphia, 1928.
20. Fort, W. A. Cancer metastatic to bone. *Radiology*, 1935, *24*, 96–98.
21. Freund, L. Quoted by Leddy.[42]
22. Geschickter, C. F., and Copeland, M. M. Tumors of Bone. American Journal of Cancer, New York, 1931.
23. Giles, R. G. Skeletal metastasis from primary carcinoma of breast. Am. J. Roentgenol. & Rad. Therapy, 1925, *14*, 442–448.
24. Ginsburg, S. Osteoplastic skeletal metastases from carcinoma of breast; report of unusual case. *Arch. Surg.*, 1925, *11*, 219–236.
25. Ginsburg, S. Pain in cancer of the breast; its clinical significance with special reference to bone metastases. *Am. J. M. Sc.*, 1926, *171*, 520–535.
26. Goforth, J. L. Consideration of body resistance to neoplasia. *Am. J. M. Sc.*, 1928, *175*, 504–510.
27. Gray, A. L. Discussion of paper by A. B. Moore. Roentgenologic study of metastatic malignancy of the bones. Am. J. Roentgenol. & Rad. Therapy, 1919, *6*, 589–593.
28. Grier, G. W. Radiation treatment of malignancy. Am. J. Roentgenol. & Rad. Therapy, 1926, *15*, 436–444.
29. Gross, S. W. Skeletal metastases in carcinoma of breast. *Am. J. M. Sc.*, 1888, *95*, 219.
30. Handley, W. S. Cancer of the Breast and Its Treatment. Second edition. Paul B. Hoeber, New York, 1922.
31. Handley, W. S. Origin of bone-deposits in

breast cancer. *Surg. Clin. North America*, 1927, *7*, 1–6.

32. Harrington, S. W. Carcinoma of the breast; surgical treatment and results 5, 10 and 15 years after radical amputation. *Surg., Gynec. & Obst.*, 1933, *56*, 438–441.
33. Harrington, S. W., and Judd, E. S. Carcinoma of the breast; surgical treatment and results 5, 10 and 15 years after radical amputation. *Surg., Gynec. & Obst.*, 1934, *58*, 440–441.
34. Harrington, S. W. Carcinoma of the breast; surgical treatment and results 3, 5, 10, 15 and 20 years after radical amputation. *Journal-Lancet*, 1934, *54*, 542–548.
35. Holfelder, H. Quoted by Leddy.[42]
36. Holmes, G. W. Discussion on a case of recurrent carcinoma of the breast treated with x-rays. *Boston M. & S. J.*, 1927, *197*, 1001–1003.
37. Jacobs, A. W. Skeletal and pulmonary metastases from carcinoma of the breast; treatment by radiation. *Med. J. & Rec.*, 1927, *125*, 237–239.
38. Jenkinson, E. L. Roentgen treatment of breast carcinomata. *Radiology*, 1924, *2*, 151–155.
39. Joly, C. A. Quoted by Leddy.[42]
40. Kaufmann, E. Textbook of Pathological Anatomy. Translated by Reimann. P. Blakiston's Son & Co., Philadelphia, 1929, Vol. II.
41. Kolodny, A. Relation of bone marrow to lymphatic system; its role in spreading of carcinomatous metastases throughout the skeleton. *Arch. Surg.*, 1925, *11*, 690–707.
42. Leddy, E. T. Roentgen treatment of metastasis to the vertebrae and bones of the pelvis from carcinoma of the breast. Am. J. Roentgenol. & Rad. Therapy, 1930, *24*, 657–672.
43. Lee, B. J., and Herendeen, R. E. Treatment of primary inoperable carcinoma of the breast by radiation. *Radiology*, 1924, *2*, 121–136.
44. Lee, B. J., and Tannenbaum, N. E. Recurrent inoperable carcinoma of breast; analysis of 363 cases treated by radium and roentgen ray. *J. Am. M. Ass.*, 1926, *86*, 250–256.
45. Lemaitre, L. Quoted by Leddy.[42]
46. Lenz, M., and Freid, J. R. Metastases to skeleton, brain and spinal cord from cancer of the breast and effect of radiotherapy. *Ann. Surg.*, 1931, *93*, 278–293.
47. Levin, I. Prognostic and therapeutic significance of skeletal metastases in carcinoma of the breast. *Ann. Surg.*, 1917, *65*, 326.
48. Matthews, A. A. Secondary carcinoma of the bone. *New York M. J.*, 1915, *101*, 1150–1157.
49. Meyerding, H. W., Carman, R. D., and Garvin, J. D. Metastasis to the bones from carcinoma of the breast; roentgenologic study. *Radiology*, 1925, *5*, 486–489.
50. Neal, M. P., and Robnett, D. A. Generalized osseous metastases secondary to atrophic scirrhous carcinoma of left breast. *Arch. Surg.*, 1927, *14*, 529–541.
51. Osler, W. Medical aspects of cancer of the breast. *Brit. M. J.*, 1906, *1*, 1–4.
52. Pancoast. Quoted by Leddy.[42]
53. Pfahler, G. E. Treatment of metastatic carcinoma of the spine by deep roentgen therapy. *Surg., Gynec. & Obst.*, 1919, 29, 236–241.
54. Pfahler, G. E. Roentgen treatment of metastatic carcinoma of the bone. *Acta radiol.*, 1926, *7*, 280–288.
55. Piney, A. Carcinoma of bone-marrow. *Brit. J. Surg.*, 1922, *10*, 235–252.
56. Piney, A. Recent Advances in Hematology. Second edition. J. & A. Churchill, London, 1928.
57. von Recklinghausen. Quoted by Kaufmann and by Piney.
58. Risley, E. H. Skeletal cancer. *Boston M. & S. J.*, 1915, *172*, 584–587.
59. Rynearson, E. H., and Hench, P. S. "Rheumatism" that requires morphine. *Med. Clin. North America*, 1913, *15*, 153–161.
60. Sanson. Quoted by Piney.
61. Schlesinger, H. Die Diagnose und Therapie der karzinomatösen Wirbelmetastasen. *Wien. klin. Wchnschr.*, 1928, *41*, 205–206.
62. Schmidt, M. B. Quoted by Piney.
63. Stenstrom, K. W., and Ericksen, L. G. Roentgen therapy of bone metastasis of carcinoma. *Radiology*, 1932, *18*, 741–753.
64. Sutherland, C. G., Decker, F. H., and Cilley, E. I. L. Metastatic malignant lesions in bone. *Am. J. Cancer*, 1932, *16*, 1457–1488.
65. Thiele. Quoted by Downs and Hastings.
66. William, W. Roger. Natural History of Cancer. William Wood & Co., New York, 1908.

SOME EXPERIENCES IN THE TREATMENT OF BRONCHIAL CANCER*

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ONE of the greatest difficulties of our modern day therapy of bronchial cancer seems to be our inability to make a sufficiently early diagnosis to assure even a minority of these patients a fair hope of ultimate recovery. In fact, most of the cases are referred when the treatment of the disease can be only palliative. Therefore if we are going to achieve any success from either surgical, radiation or combined therapy, the cases must be referred for treatment in an earlier stage of the disease, even before the commonly accepted sign of manifest atelectasis. This earlier diagnosis will only be possible under a most carefully developed alert consciousness of the possibility of bronchial cancer and should include such case finding methods as annual chest photofluorography of the adult population in addition to the interim examination of any individual displaying any pulmonary symptomatology or other insidious or masked findings which might be even indirectly referable to bronchial cancer. I refer here to those atypical cases with insidious non-pulmonary onset which in a previous survey made by us comprised 15 per cent of a series of 73 cases of bronchial cancer.

Another difficulty is the proper evaluation of any therapy which attempts to deal solely with the local disease in the average case of bronchial cancer because of the commonly observed tendency of such lesions of early vascular dissemination through ulceration into the tributaries of the pulmonary veins. This probability of early and widespread dissemination, in addition to the early lymphatic permeation toward the hilar nodes, brings one face to face with the concept of immunity to cancer cells. In bronchial cancer, especially, it would seem that we must postulate such a theory of immunity if we are to explain the apparently successful disposal of undoubted myriads of cancer emboli which break into the general circulation, while only a relatively few ever seem able to establish growth and create recognizable metastases.

For some years past we have assumed, in agreement with Fried, a theory of origin of these tumors from basal islands of primordial epithelial cells underlying the bronchial mucosa and have recognized five arbitrary types resulting from such cellular metaplasia. These pathologic types have previously been described by us and will not be dwelt on here

From a therapeutic viewpoint, the most we can expect to achieve is to maintain the resistance of the host while we attempt to render innocuous any potent mass of active pulmonary disease, either by surgical extirpation or radiation sterilization or by both, so as to prevent further dissemination. Therapy, therefore, to achieve beneficial results should begin early in the course of the disease with the hope that the tumor can be successfully removed or sterilized before generalized metastases have taken place.

Most of our patients were in the fourth to the seventh decade of life. Approximately 30 to 40 per cent had demonstrable metastases to the hilar nodes, opposite lung, bones, superficial nodes or brain. Over one-third were poor risks for any therapy. There is left, therefore, a small group, probably 10 to 15 per cent at the most, to whom exploratory thoracotomy might be applicable. Even in this hopeful group we had difficulty in persuading them against their own set desires and those of their referring physicians that such exploratory operation offers the best hope of cure. The

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result is that most patients either of necessity or desire come to radiation treatment and only a few to surgery. However, in the small number of our cases that have come to surgery, including several referred for postoperative roentgen therapy, we have observed a successful result in one, which will be referred to later.

To date our best results from radiation therapy of bronchial cancer seem to have been achieved with 200 kv. cross fired so as to build up a total radiation of 12,000 r with properly directed and angulated portals, distributed over two anterior and two posterior fields. A supplemental course of similar irradiation after one to two months, through previously unirradiated portals, probably three in number, in order to cross fire into the site of the lesion, may be given. In a few selected cases where the intrabronchial tumor is accessible, gold radon seeds may be implanted through the bronchoscope.

In the supervoltage range, it would seem from our experience so far that good results may be expected especially with 400 kv. and its resulting heavier filtration as exemplified in a case to be herein cited. With 1,000 kv. one might theoretically expect even better results, but so far the results, while immediately encouraging in establishing early palliation and often apparent improvement in aeration, have been ultimately discouraging in that this improvement has been too short in duration. However, improvement in technique may bring about better results in the future.

I wish briefly to report 4 cases where a histopathologically proved malignant growth in the bronchus has apparently disappeared at subsequent bronchoscopic examinations under radiation therapy for a sufficient length of time to make one hopeful that such therapy may and will, if skillfully managed, accomplish lasting results.

CASE REPORTS

Case 1. R. L. R., white male, married, aged thirty, occupation a weigh master for a coal company for the past thirteen years, was admitted to the tumor clinic at the State Institute for the Study of Malignant Diseases on May 24, 1937.

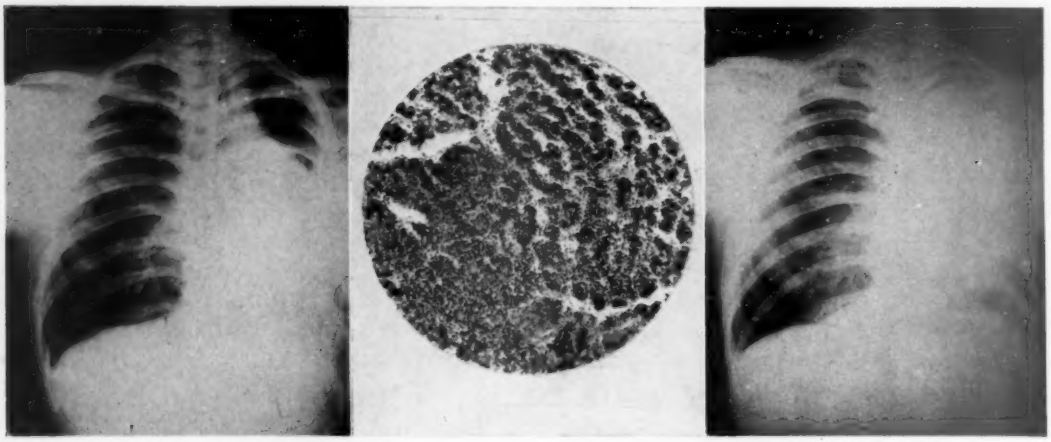
Chief Complaint. Chronic cough since 1934 with soreness in left chest and dyspnea. About 1936 cough became more severe, he spit blood and was told the left lung had collapsed. He had previously been admitted to the Buffalo General Hospital in January, 1937, where he had several bronchoscopies, with biopsy, and where a microscopic and clinical diagnosis of bronchial carcinoma was made. He had a series of twenty roentgen treatments there. On discharge he was still troubled with cough and soreness of the left chest. He weighed 149 pounds. The pathological tissue report from that hospital was carcinoma of the left bronchus showing infiltrating small round cells with, in some areas, attempt at gland formation.

Chest Examination. Diminished breath sounds over left chest, trachea pulled to left, with sounds almost absent over the lower two-thirds of left chest and percussion note approaching flat. Heart pulled to left, rhythm rapid but regular, no murmurs or increase in size noted. Roentgenogram of the chest showed a large, diffuse, triangular shadow with the apex directed toward the clavicle, occupying the lower three-quarters of the left lung. Right lung was normal. Heart normal in size and contour but displaced to the left. A lateral roentgenogram confirmed the findings in the posteroanterior view and showed dense shadow in the left hilar region with increased linear marking radiating therefrom and some aeration at the base and apex.

From a review of the previous roentgenograms both here and at the Buffalo General Hospital and also the clinical findings and microscopic tissues previously secured, a diagnosis of bronchial carcinoma of the left lower lobe was confirmed.

Treatment. From June 10 to July 22, 1937, roentgen therapy was given as follows: 200 kv. at 80 cm. skin target distance, using 10 by 15 cm. fields, 0.9 mm. Cu half-value layer, directed over the left hilar region, two anterior and two posterior, so as to converge in the region of the left hilum. The two anterior fields were treated one day with 200 r each and the two posterior fields the following day and so on until a total of 3,000 r, measured in air, was given over all fields.

On March 30, 1938, the following note was recorded: Patient spent winter in the South. He



A *B* *C*

Fig. 1. Case 1. *A*, roentgenogram of the chest on admission. *B*, photomicrograph showing adenomatous tumor. *C*, roentgenogram after pneumectomy.

has a slight cough, feels quite well, no hemoptysis, little skin reaction on chest and no apparent change in the chest roentgenogram.

On September 13, 1938, a bronchoscopy showed the tracheobronchial tree displaced to the left. In the left bronchus about 1½ inches from the carina there was a coarsely lobulated tumor attached to the lateral wall by a moderately broad base which almost filled the lumen of the lower lobe bronchus. The mucosa over this tumor did not appear ulcerated. The right bronchus and its subdivisions were fairly normal. The base of the tumor mass in the left lower bronchus was transfixed with 1 mc. gold radon seeds and a section taken for biopsy. I was led to believe from the history to date and the appearance of the tumor on bronchoscopy that this was an adenoma, although the pathologist still reported a carcinoma of the small cell type.

On November 14, 1938, the patient maintained a stationary body weight. He had slight dyspnea and only occasional streaking in the sputum. Chest roentgenogram showed increased aeration over the upper border of the dense lower half of the left lung field; otherwise there was little change.

On March 21, 1939, bronchoscopy showed a globular tumor arising from the lateral wall of the left lower lobe bronchus about 1½ inches from the bifurcation, which filled approximately two-thirds of the lumen. The surface was smooth, not ulcerated and was again reported by me as resembling an adenoma. The base was again planted with two gold radon seeds of previous size and the mass coagulated through the bronchoscope. The right bronchus was not remarkable. After consultation with the pathological staff it was now conceded that the biopsy taken at this time was not unlike adenoma.

On July 25, 1939, the patient complained of some dyspnea, increasing malaise and some cough. A bronchoscopy was again performed with the hope of instituting better drainage and aeration of the left lower lobe. The adenoma was observed as before below the upper lobe bronchus of the left bronchial tree. An unsuccessful attempt was made to apply a snare about this mass and an exploratory thoracotomy was suggested to the patient which he then refused upon advice of his referring physicians, preferring as they had recommended to continue as he was so long as he was having such satisfactory palliation.

On October 24, 1939, patient was again bronchoscoped to improve aeration and drainage. The left bronchus showed a shelving, partially obstructing mass in the left lower lobe stem about 1½ inches from the carina. The mucosa over it was roughened but not ulcerated. There was apparently less obstruction. The tumor was again coagulated by me through the bronchoscope and a section taken. Section was again reported adenoma.

On April 9, 1940, the patient again complained of malaise, some low grade fever, night sweats, loss of weight, and so forth, which he had now learned to associate with lack of drain-

age and aeration. Bronchoscopy at this time showed practically little obstruction at the site of the tumor in the left bronchus. The bulk of the tumor had apparently disappeared leaving only what seemed to be a thickened scar of the mucosa. As he said he was getting tired of his recurrent invalidism, exploratory thoracotomy with the hope of removing the fibrotic infected left lower lobe was again suggested. This time the patient consented.

On March 12, 1941, the patient was operated on, a left pneumonectomy being performed at the New England Deaconess Hospital in Boston, Massachusetts, by Dr. R. Overholt. The pathologic tissue, after extensive study of the removed left lung by Dr. Shields Warren, showed a chronically infected fibrotic left lower lobe but no sign of the original tumor in the bronchus. After reviewing the biopsy sections taken here before operation the diagnosis of adenoma was also concurred in by them. When last seen the patient had returned to work and was feeling the best he had felt in years.

Figure 1 shows roentgenograms before and after therapy, and a photomicrograph of the lesion.

Case II. R. F. K., white male, aged forty-nine, occupation clerk, was admitted to the State Institute for the Study of Malignant Diseases tumor clinic with a previous diagnosis of carcinoma of the lung on May 29, 1939.

Chief Complaint. Stomach trouble, i.e., nausea and vomiting a year ago which was repeated again six weeks ago. He had lost 5 pounds in weight and complained of a dry, hacking, unproductive cough. Chest examination showed sonorous rhonchi throughout both lungs, with compensatory breath sounds over the right lung and diminished respiratory murmur over the left anterior middle lung field. The roentgenogram on admission is shown in Figure 2*A*.

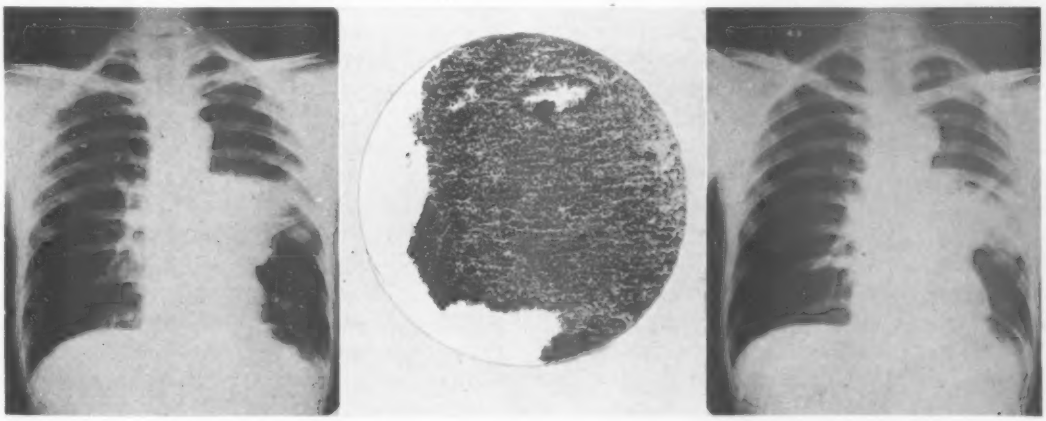
On June 6, 1939, bronchoscopic examination was not remarkable except in the left lower lobe bronchus where in the terminal portion the mucosa appeared thickened and folded. Biopsy showed a carcinoma of small round cell type.

On July 19, 1939, 200 kv. roentgen therapy, as in the previous case, was advised because the patient had refused exploratory thoracotomy. Treatment was started on August 14, 1939, with 400 r daily over the anterior left hilar region, followed by the same dose the following day, and so on, alternating until 3,129 r, measured in air, was given over each field. Treatment had to be discontinued as the patient did not tolerate it well. Treatment was again given November 3 to December 5, 1939, with 350 r daily as before up to 3,910 r total to each field.

On February 21, 1940, on bronchoscopy I was unable to find any evidence of the bronchial carcinoma in the left lower lobe bronchus although the roentgenogram still showed some density about the left hilar region.

On April 17, 1940, the patient had gained 5 pounds, was working daily and was very much pleased with the improvement shown to date.

On June 19, 1940, the patient returned to the clinic after a prolonged illness, apparently, from



A *B* *C*

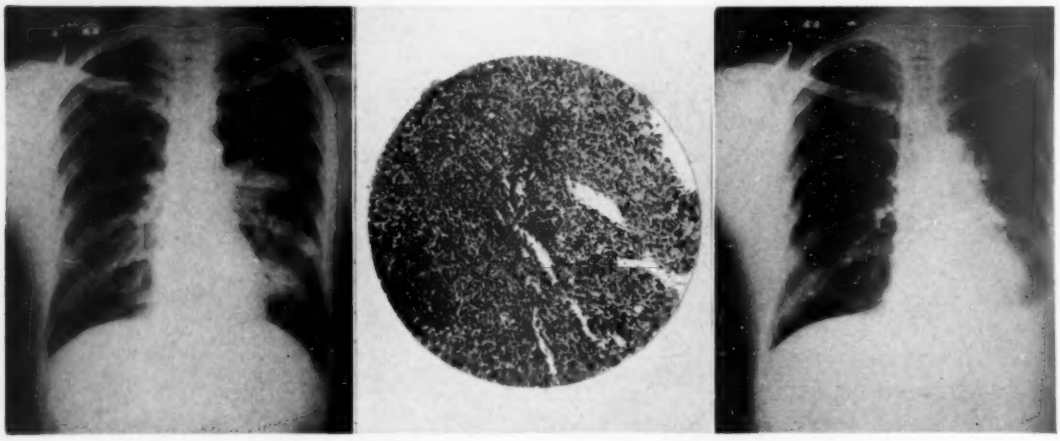
Fig. 2. Case II. *A*, roentgenogram of the chest on admission. *B*, photomicrograph showing small round cell carcinoma. *C*, recent roentgenogram of the chest showing final result following roentgen therapy.

the records of another hospital, a spontaneous pneumothorax of the left lung. He was still weak and would not consent to bronchoscopy.

By July 1, 1940, he had gained considerable weight and was feeling quite well. He still did not wish to consent to bronchoscopy. Roentgenograms showed some improvement.

On May 16, 1942, he felt fine and weighed 130 pounds. His weight has been stationary for some months. He is looking for light work.

nant epithelial tumor, containing "fairly large round cells with large pale nuclei." Mitotic figures were frequent with areas of necrosis. No lesion was then suspected in the upper respiratory tract to account for these findings and the patient had no other complaint. These nodes regressed somewhat following subsequent roentgen therapy, but were still palpable. Chest roentgenogram showed slight density of the left hilum but was otherwise negative.



A *B* *C*

Fig. 3. Case III. *A*, roentgenogram of the chest showing findings on admission. *B*, photomicrograph of section taken from the bronchus showing small round cell carcinoma. *C*, recent roentgenogram of chest following roentgen therapy.

The photomicrograph of the lesion is shown in Figure 2*B* and a roentgenogram of the chest following roentgen therapy in Figure 2*C*.

Case III. R. D. K., white male, aged thirty-eight, married, engaged as a linotypist for past fifteen years. He was admitted first on February 19, 1937 to the tumor clinic of the State Institute for the Study of Malignant Diseases on account of basal cell epithelioma of the skin of the left ala of the nose. He was again readmitted July 2, 1937, at which time the lesion on the nose remained healed but an indurated node had appeared in the upper cervical region near the angle of the right lower jaw, with smaller nodes running downward along the sternomastoid muscle. A clinical diagnosis of mixed salivary tumor was tentatively made and eight daily roentgen treatments of 400 r each was given over the area with 200 kv. When the mass became larger a biopsy was taken September 10, 1937, which showed metastatic malig-

On May 21, 1940, after remaining without change for some time the patient came in with definite nodes in the left supraclavicular region. He had had pleurisy with effusion since he was last seen and had been tapped three weeks before. There was no recurrence of the basal cell lesion of the left side of the nose. No tumor was palpable in the right neck region but the skin here showed telangiectasia. He had some wheeze, no apparent cough and but slight dyspnea. The pharynx and larynx were negative. Roentgenogram of the chest now showed a large nodular density in the left hilar region extending from its upper portion. The borders were irregular and the markings intensified into the surrounding lung field. No definite changes were seen in the right lung. The roentgenologist suggested a diagnosis of primary bronchial carcinoma and the patient was referred to the bronchoscopic clinic.

On May 28, 1940, bronchoscopy disclosed a tumor arising from the lateral wall of the left

bronchus about 1 inch below the carina. The surface was smooth and suggested an adenoma. Section was taken but otherwise the bronchoscopic examination was not remarkable. Pathologic report was "carcinoma, small round cell type."

From June 24 to July 22, 1940, 200 kv. roentgen therapy was given daily over the density in the left hilar region, as in Case 1, using an anterior superior and inferior and a posterior superior field all converging in the region of the left hilus. Three hundred roentgens, measured in air, was given over the two anterior fields one day and over the two posterior fields the next, alternating in this way up to a total of 3,690 r per field. The patient was quite ill following this therapy but eventually overcame the reaction satisfactorily.

On December 30, 1940, he had only slight cough, no expectoration or hemoptysis, slight "tightness" of the left chest. He has gained 30 pounds and appears to be in good condition. A roentgenogram of the chest showed marked improvement, the density in the left hilar region having greatly decreased.

On March 18, 1941, the bronchosope was passed without the aid of the laryngoscope at which time the tracheobronchial tree was found to be negative throughout with no sign of malignancy in the left bronchus. The patient weighs 170 pounds, feels fine, works daily as linotypist, and against advice lifts heavy bundles of paper at times.

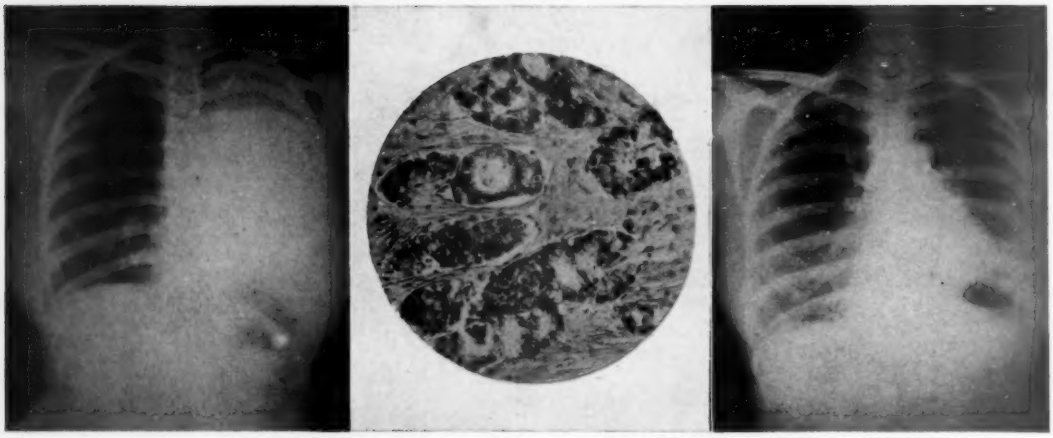
May 7, 1942. Patient weighs 187 pounds, has no cough, no hemoptysis, no signs of recurrence in the right neck region but there is some telangiectasia of the skin of the neck. He continues to work daily and feels fine. Figure 3 shows roentgenograms taken before and after roentgen therapy and a photomicrograph of the lesion.

Case IV. C. H., white female, aged fifty-three, school teacher for the past twenty-three years. Admitted to the State Institute tumor clinic on February 11, 1938, with cancer of the right pyriform fossa of the hypopharynx for which she was referred for therapy. She had been intermittently hoarse for the past four months and she also had some difficulty in swallowing. Examination by mirror laryngoscopy showed ulcerated mucosa in the right pyriform sinus region with abductor paralysis of the right vocal cord. There was a hard node in the right anterior cervical triangle over which there was a skin scar from previous operation for biopsy, which had shown a metastatic epithelioma. Under direct laryngoscopy a papillomatous ulcerated mass was removed from the right pyriform sinus which on section showed an epithelioma of differentiated cell type. A roentgenogram of the chest at this time showed only some calcified nodes in both hila, especially the left, where one approximately 1 cm. in diameter was noted. Roentgen therapy was given using 200 kv. at 50 cm. skin target distance, through a 100 sq. cm. field over the right and left hypopharyngeal region. A daily dose of 200 r was given to one of these fields, alternating right and then left, from February 11 to March 28, 1938, until a total dosage of 6,095 r, measured in air, per field was reached. Following this the patient made an uneventful recovery, showing no signs of recurrence in the right pyriform sinus or any node in the neck on several subsequent examinations, including even direct laryngoscopy. The patient returned to her work as a school teacher.

On October 27, 1941, following complete freedom from the previous condition, the patient was again referred, with a history of losing weight, shortness of breath, dry cough and hemoptysis. She brought roentgenograms which were suggestive of bronchial occlusion, i.e., atelectasis of the left lung. Examination of the right pyriform sinus and upper cervical region still showed no evidence of recurrence, now over three years. Bronchoscopy on October 28, 1941, showed the larynx and trachea to be negative. There seemed to be some forward displacement of the bifurcation. The right bronchus was negative but the left just beyond the carina was occluded with an ulcerating tumor mass.

A biopsy was taken and enough of the occluding mass removed to establish an air way. The histopathologic diagnosis was epithelioma of the bronchus with some keratinization. This was apparently a second primary tumor.

A roentgenogram of the chest at this time showed a diffuse shadow of the entire left lung field except in the left supraclavicular region where there was still some aeration. The left dome of the diaphragm was elevated. The right lung field was practically negative and the left lateral roentgenogram showed increased hilar density extending upward and forward to the chest wall.



A *B* *C*

Fig. 4. Case iv. *A*, roentgenogram of chest before therapy. *B*, photomicrograph of section from bronchus showing keratinizing squamous carcinoma. *C*, roentgenogram of chest following 400 kv. roentgen therapy.

Roentgen treatment was given over the left lung, with 400 kv., using an anterior, left lateral and posterior fields at 70 cm. skin target distance. A 10 by 15 cm. field was used in each case giving 100 r through each of the three fields daily. The treatment was started October 31 and continued to December 12, 1941, for 35 cycles with a total of 4,620 r, tissue measured, over both the anterior and posterior field and 3,850 r over the lateral field with all three beams converged toward the left hilum.

The result to date has been an almost complete re-aeration of the left lung, although the left diaphragm is still displaced upward. The heart is also displaced slightly to the left with some residual density in the left hilum. Bronchoscopic examination on April 6, 1942, showed some thickening of the mucosa at the previous site of the tumor in the left bronchus but no signs of recurrence. Figure 4 shows roentgenograms taken before and after roentgen therapy, and a photomicrograph of the lesion.

CONCLUSION

The above remarks and citations of four case histories will serve, it is hoped, to portray an impression of our experience in the treatment at this clinic of 147 cases of bronchial carcinoma. While it is still too early to draw any final conclusions, it would seem that it is possible to produce more lasting palliation or even arrests with radiation therapy than is more commonly reported. In our cases now living, approximately 3 per cent of the total treated, an arrest has been secured for over three to five years in some. Such results, while not entirely unusual, are generally more optimistic than many reports on the surgical, radiation or combined treatment of this condition cited in the recent literature.*

REFERENCES

1. Fried, B. M. Primary carcinoma of the lung; bronchiogenic cancer—clinical and pathological study. *Medicine*, 1931, *10*, 373–508.
2. Mattick, W. L., and Burke, E. M. Primary bronchogenic carcinoma from pathologic and radiologic points of view. *J. Am. M. Ass.*, 1937, *109*, 2121–2125.
3. Overholt, R. H. A common masquerading lung disease. *New York State J. Med.*, 1942, *42*, 1657–1662.
4. Pack, G. T., and Livingston, E. M., Editors. Treatment of Cancer and Allied Diseases. Vol. 1. Paul B. Hoeber, Inc., New York, 1940.

* All patients described in the herein contained case histories are alive and well at the date of submission of this article for publication.

CARDIAC ANEURYSM*

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CARDIAC aneurysm, which before the days of the roentgen ray almost invariably eluded diagnosis until the patient came to the autopsy table, has, with the advent of roentgenoscopy and roentgenography come to be described more and more frequently, and with a diagnostic precision which admits of relatively little uncertainty. The great variety of clinical symptoms and physical signs which had previously been accorded some diagnostic merit and which have now been conceded as belonging to a host of cardiac ailments have been relegated to a forgotten niche, and dismissed as never having had much value after all.

Steel[15] comments upon Pletnew's review of 300 cases in 1926. Of these only 6 were diagnosed in life, and in only 1 of the 6 was the lesion visualized by means of the roentgen ray.

The same author points out that among the earliest reports of cardiac aneurysm is to be found that of Olaus Borrich, who in 1676 reported an aneurysm of the right auricle; and of Pierre Dionis who in 1696 reported one of the right ventricle; and of Dominic Galeati who in 1757 reported one of the left ventricle. In 1900 Fujinami reported a case with three aneurysms, one at the apex, one in the posterior wall below the mitral orifice, and one of the septum; Thurman had, in 1838, reported a case in which four aneurysms were found in the left ventricle.

The first roentgen report appears to have been that of Sézary and Alibert[13] in 1922; it is very complete and conclusive, and calls attention to the comparative findings in the oblique positions. The first roentgen report with autopsy confirmation was apparently by Link, in 1927.[10]

ETIOLOGY AND PATHOLOGY

Almost all cardiac aneurysms are due to coronary thrombosis; among the other very occasional causes must be listed abscess of the cardiac wall, trauma, ulcerative endocardial lesions, and congenital lesions.

Cardiac aneurysm may be found as early as six weeks after a coronary occlusion. In a series of 145 cases reported by Shookhoff and Douglas[14] the average age of the patients was 57.8 years, with only 3 patients in this series being under the age of forty. The authors add a case of their own only thirty-five years of age.

The usual sequence of events appears to be anemic necrosis and myomalacia, followed by fibrosis. Frequently there is a thrombus in the sac. Pleuropericardial adhesions are frequent.

Steel has given an excellent summary of the pathologic findings and of the anatomic structures involved. The left coronary artery arises in the left sinus of Valsalva, and is usually larger than the right. Just below its origin it divides into the anterior descending ramus (which gives off large branches to the ventricular septum and left ventricle, and smaller branches to the left atrium. Anastomoses are common throughout, not only between the right and left coronary arteries in their capillary and precapillary distribution, but also between coronary arteries and vessels of adjacent and attached organs and between branches of each coronary. These anastomoses involve the fine peripheral branches in the subendocardial and subpericardial layers.

Infarcts have a roughly triangular outline with the base toward the endocardium and the apex toward the epicardium; hyperemia and coagulation necrosis are followed by fibrosis, with abundant elastic

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tissue present. As healing progresses the wall of the infarct near the epicardium becomes thinner, the end-result being a white scar.

About 85 per cent of these aneurysms are in the left ventricle; 2 to 5 per cent of them occur in the right ventricle. Other locations may be the interventricular septum, or the sinus of Valsalva.

The aneurysmal wall is usually from 1 to 3 mm. in thickness.

About 80 per cent of cardiac aneurysms occur in males.

Aneurysms situated in the right sinus of Valsalva may perforate into the right ventricle; a few of these are congenital in origin. When acquired, they are often due to ulcerative endocarditis. Aneurysms of the sinus of Valsalva may be intravalvular.

Schwedel and Gross,[12] in a review of 81 cases of cardiac aneurysm, found 3 of the right ventricle, 48 in the anterior or lateral portion of the left ventricle, 21 in the posterior portion of the left ventricle; 24 per cent of the entire series had pericardial adhesions.

Syphilis plays a very minor rôle in the development of these cardiac aneurysms; the total number of reported luetic cardiac aneurysms appears to be about 19 (Braunstein, Bass and Thomas[2]). Cookson[3] has given an interesting account of the pathology in a luetic aneurysm.

In this case, three cavities or aneurysmal dilatations occupied the posterior portion of the left ventricle; their diameters were respectively 1½ in., ½ in. and ½ in. Their ventricular surfaces were covered with rough, injected granulation tissue; externally they were covered by an area of pericardial thickening. On section the walls were found to consist of fibrous tissue containing considerable deposits of calcium. All the valves were normal; all the coronary branches were patent. The patient was a female, aged forty-three.

In short, the pathology of luetic cardiac aneurysm appears to be the pathology of gumma.

Rupture is rare, death usually occurring (and that, in most cases, about two years after the diagnosis is made) from another attack of the same sort of coronary occlusion which originally produced the aneurysm. Hunter and Benson[6] have described the pathologic findings in a case of rupture. This patient had had an attack of coronary thrombosis three months before; the aneurysm was situated on the anterolateral wall of the left ventricle. There was a surrounding area of fibrous adhesions 7.8 by 4.5 cm. in extent binding the epicardium and pericardium together. Similar bands obliterated the pericardial space over the surface of a mushroom-like mass situated well up toward the atrioventricular sulcus and between the anterior interventricular and circumflex branches of the left coronary artery. Along the inferior border of this pouch, 1 cm. lateral to a line drawn through its center, was a slit-like ragged-edged opening 4 mm. in length. A probe passed through inside this defect, led through the 1 mm. wall at the base of the aneurysm into its cavity, which lay over the external surface of the left ventricle. The aneurysm measured 4 by 4 by 3 cm.; its wall varied from 1 to 7 mm. in thickness.

ROENTGEN FINDINGS

The posteroanterior roentgenogram of the chest gives adequate information in a great many instances, since most of the aneurysms are situated in the left ventricle, and the characteristic shadow is brought out with satisfactory definition. Aneurysms involving the cardiac apex may be elusive unless care is taken to examine this area well in deep inspiration. Roentgenoscopy should, of course, not be dispensed with in any case, even in those in which the diagnosis seems apparent from the posteroanterior roentgenogram. The reason for this caution is well illustrated by the following experience of Sauerbruch,[11] and one which details what is probably the only successful surgical attack upon a cardiac aneurysm:

Sauerbruch, in addressing his clinic, presented a roentgenogram which gave evidence of a mediastinal mass; this mass, he

pointed out, seemed to duplicate almost exactly another one which had been a mediastinal tumor and upon which he had operated at a very recent date. The appearances in the two roentgenograms were so alike, indeed, that Sauerbruch felt confident that the second mass must be a tumor very similar to the first; consequently, he performed an exploratory operation.

Upon dissecting out the mass, Sauerbruch found a cardiac aneurysm; the dissection had already progressed too far to

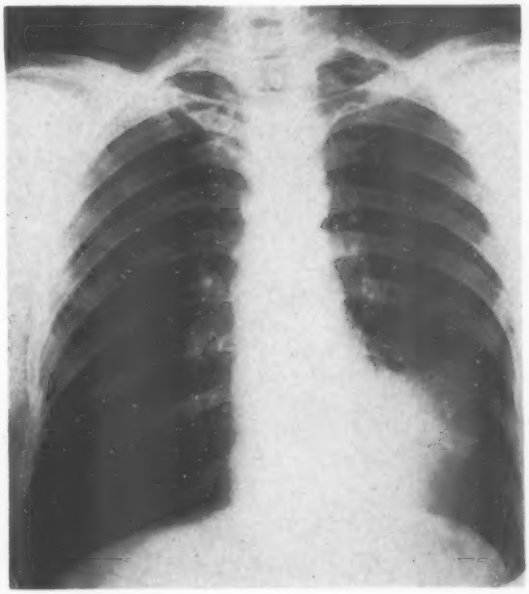

Fig. 1. Left ventricular aneurysm, posteroanterior projection.

permit of closure with no attempt at reparative surgery. This he went about and, reporting the case some weeks later, was able to say that the patient was convalescing very satisfactorily, a plastic operation having been done upon the cardiac wall.

Much stress has been laid upon the "contrapulsatile" expansion of a ventricular aneurysm. This merely means that when the ventricle goes into systole, the aneurysmal sac dilates, taking on a "paradoxical" motion. The value of this sign has no doubt been greatly exaggerated, for many observers have testified that in their cases it was absent altogether.

Fig. 2. Left ventricular aneurysm, right anterior oblique projection.

Brams and Gropper[1] have called attention to the fact that apical aneurysms may

Fig. 3. Left ventricular aneurysm, left anterior oblique projection.

be impossible to diagnose. This may no doubt be true of some of them, but the probability is that the great majority can be found if roentgenoscopy is carefully carried out and care taken to examine the apex with the diaphragm fully depressed in deep inspiration. Aneurysms in the apex have a tendency to develop downward, and will thus come to lie in what the French call *l'ombre hépato-diaphragmatique*. Wiberg[16] records 1 case in which an apical aneurysm produced a depression in the liver, and Lutembacher[8] calls attention to the fact that the apex may become fixed by pericardial adhesions.

Our case was a male, aged fifty-five: one year before he had been operated upon for ruptured duodenal ulcer, and while recovering from this operation had had an attack of coronary thrombosis. He had refused the period of inactivity which his physicians tried to enforce, and insisted upon an early resumption of his work as a truck driver.

Complaining of epigastric distress, he was referred for examination of the gastrointestinal tract. The aneurysm was then seen roentgenoscopically, and roentgenograms were made in the posteroanterior and right and left anterior oblique positions.

He was referred elsewhere for surgery of the aneurysm. The surgical exploration confirmed our description of the aneurysm as being situated on the anterolateral wall of the left ventricle.

The patient did not survive the surgical procedure.

SUMMARY AND CONCLUSIONS

1. The majority of cases of cardiac aneurysm follow attacks of coronary thrombosis; other very occasional causes are abscess of the heart wall, trauma, ulcerative endocarditis, and congenital defects.

2. About 85 per cent of the cases of cardiac aneurysm involve the left ventricle; twice as many occur on the anterior as on the posterior wall of the left ventricle. Only about 2 to 5 per cent of cardiac aneurysms involve the right ventricle. Other rarer locations may be the interventricular septum or the sinus of Valsalva.

3. The wall of a cardiac aneurysm is usually from 1 to 2 mm. in thickness. Despite this, death from rupture of an aneurysm is rare, the patients usually succumbing to another attack of coronary thrombosis.

4. The average life expectancy, once the diagnosis of cardiac aneurysm has been made, is a little less than two years, but in some cases has been as long as seven years.

REFERENCES

1. BRAMS, W. A., and GROPPER, A. Cardiac aneurysm. *Illinois M. J.*, 1940, *78*, 246–252.
2. BRAUNSTEIN, A. L., BASS, J. B., and THOMAS, S. Gummatous myocarditis and aneurysm of left ventricle, with nodal tachycardia, and subsequently, bundle branch block. *Am. Heart J.*, 1940, *19*, 613–622.
3. COOKSON, H. Case of cardiac syphilis with ventricular aneurysms. *Brit. M. J.*, 1929, *2*, 94–95.
4. FOGEL, E. I. Aneurysm of left ventricle following coronary infarct in living patient. *J. Am. M. Ass.*, 1933, *100*, 39–41.
5. FULTON, M. N. Aneurysm of ventricle of heart. *J. Am. M. Ass.*, 1941, *116*, 115–122.
6. HUNTER, W. C., and BENSON, R. L. Rare form of saccular aneurysm with spontaneous rupture. *Am. J. Path.*, 1933, *9*, 593–602.
7. KRAUS, F. Ueber die Möglichkeit der klinischen Diagnose intrakardialer Aneurysmen. *Berl. klin. Wchnschr.*, 1919, *56*, 529–532.
8. LUTEMBACHER, Quoted by Wiberg.[16]
9. PARADE, G. W. Aneurysmatische Elongation des Herzens. *Med. Klin.*, 1934, *30*, 1357–1359.
10. PETERS, J. J. Aneurysm of left ventricle. AM. J. ROENTGENOL. & RAD. THERAPY, 1941, *45*, 371–378.
11. SAUERBRUCH, F. Enfolgreiche operative Beseitigung eines Aneurysma der rechten Herzkammer. *Arch. f. klin. Chir.*, 1931, *167*, 586–588.
12. SCHWEDEL, J. B., and GROSS, H. Ventricular aneurysm; roentgenographic and post-mortem surveys. AM. J. ROENTGENOL. & RAD. THERAPY, 1939, *41*, 32–36.
13. SÉZARY, A., and ALIBERT, J. Anévrisme pariétal du coeur. *Bull. et mém. Soc. méd. d. hôp. de Paris*, 1922, *46*, 172–179.
14. SHOOKHOFF, C., and DOUGLAS, A. H. Case of acute coronary occlusion with roentgenographic evidence of early development of aneurysm of left ventricle. *Am. Heart J.*, 1931, *7*, 95–100.
15. STEEL, D. Roentgen diagnosis of cardiac aneurysms. *J. Am. M. Ass.*, 1934, *102*, 432–436.
16. WIBERG, G. Case of aneurysm of heart. *Acta radiol.*, 1931, *12*, 562–573.

TUBEROUS SCLEROSIS

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TUBEROUS sclerosis is a rare hereditary disease of ectodermal origin. Neurofibromatosis and angioma of the brain associated with a nevus in the trigeminal area together with tuberous sclerosis[13] are diseases which show definite clinical similarity and have been classified as "neurocutaneous syndromes" (congenital ectodermoses). This article is herewith presented in an effort to direct the physician's attention to the clinical and roentgenological aspects of tuberous sclerosis (neurocutaneous syndromes), inasmuch as most authors report that these cases have not been recognized. The majority of reports[10] have originated from European psychiatric institutions. Since Bourneville described the syndrome in 1880, there have been 114 cases[9] reported in the literature.

FIG. 1.

Cardinal symptoms of tuberous sclerosis are: (1) retarded mental development; (2) epileptic seizures; (3) adenoma sebaceum; (4) nodules in the brain with tendency toward cotton ball calcification, and (5) phacoma of the retina. In addition, there may be multiple skin nodules similar to neurofibromatosis, periungual tumors, rhabdomyoma of the heart, tumors of visceral organs, high and narrow or cleft palate, or other signs of maldevelopment.[3,5]

SYMPTOMATOLOGY

Patients afflicted with tuberous sclerosis are usually mentally defective and are often imbeciles. Convulsions generally begin in the first year of life. The patient seeks medical advice chiefly because of epileptic seizures. Long periods of remission are typical of the disease.[1,2] Critchley and Earl[4] report one case with a remission of seven years' duration. Convulsive seizures may be of the petit, grand mal, or jacksonian type. In spite of the diffuse distribution of cerebral lesions, spastic paralysis and contractions are rare. However, mental deterioration is progressive.

FIG. 2.

DERMATOLOGY

Adenoma sebaceum or nevus multiplex of Pringle was described in 1891. It consists of a symmetrical butterfly distribu-

tion[8] of small warty tumors over the nose, cheeks and chin. Color of the tumor[11] varies from that of normal skin to deep red, depending on the number of dilated superficial capillaries present. In addition, there may be pigmentation present in the lumbar area; skin nodules, cafe au lait spots and vitiligo. Some authors[13] are of the opinion that the term adenoma sebaceum is a misnomer because of the fact that the lesions consist of connective and vascular tissue

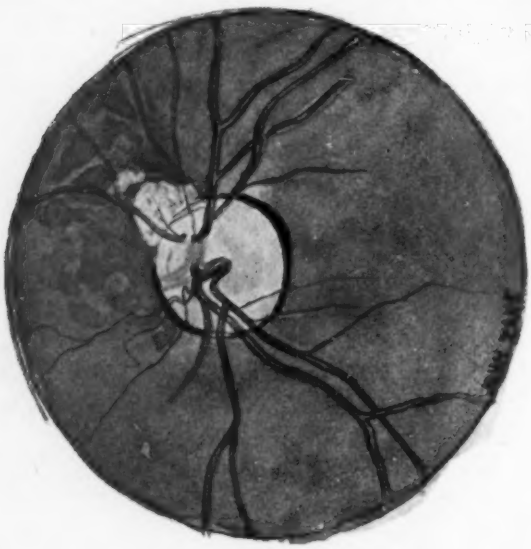

Fig. 3.

hyperplasia. They believe that the lesions often arise from the peripheral glia or Schwann's cells and therefore would be analogous to neurofibromatosis.

OPHTHALMOLOGY

In 1920, Von Hoeve described congenital tumors of the retina associated with tuberous sclerosis. He termed these lesions "phacomas." The tumors appear as small, flat, round, white or yellowish spots on the posterior fundus near the papilla.[8] Occasionally the surface of the tumor spots appears granular and refractile. For this reason, they have been called "mulberry tumors." These tumors are rarely elevated above one diopter, although there have been instances wherein they projected two to three diopters above the retina.[7] Papilledema is absent unless there is an increase in intracranial pressure.[3] Von Hoeve states that a phacoma may originate from neural

Fig. 4.

fibers or neurocytes.[7] He is of the opinion that phacomas occurring in diseases of the neurocutaneous syndromes are closely associated, although definitely of different disease entities.

Fig. 5.

ROENTGENOLOGY

Scandinavian literature is credited with being one of the first to contain reports on the roentgen findings in tuberous sclerosis. Multiple circular nodules of increased density with varying degrees of calcification are seen throughout the brain. Many of the calcifications resemble small cotton balls. Yakovlev and Corwin[12] refer to them as "brain stones." Brain calcifications in tuberous sclerosis should be differentiated from hematomas, tumors, cysts, old abscesses, aneurysms and parathyroid changes.[7] Berkwitz and Rigler[1] have demonstrated that in the absence of brain calcifications pneumo-encephalographic studies may be of value. They report one such case in a two year old epileptic girl wherein pneumoencephalograms revealed the classical "candle guttering or dripping" as a result of indentation of the ventricular system by the nodules. The septum pellucidum is absent as well. Hydrocephalus may be a pertinent finding.[10] Erosions of the clinoid processes and sphenoid wings[11] as well as hyperostosis interna[7] have been reported. Kveim,[8] and Gottlieb and Lavine[7] have described changes in the spongiosa of small bones. Yakovlev believes that the bone cysts are on the same basis as a schwannoma such as observed in Recklinghausen's disease. Renal tumors in association with tuberous sclerosis are frequently found. Some authors state that they occur in 80 per cent of the cases. Polyposis of the colon may also be present.

PATHOLOGY

Pathological examination[6,10] of the fresh brain reveals enlarged or flattened convolutions. Multiple, hard, white or grayish nodules in the cerebral convolutions feel like marbles. The ventricular lining presents hard white projections resembling "candle dripping or guttering."[6] Microscopic examination of the affected areas shows giant astrocytes and peculiarly developed nerve cells with many thick processes. These have been classified as spongioblastoma multiforme.

CASE REPORT

A thirty-two year old white soldier was admitted to the hospital for observation because of a history of epileptic seizures. Patient stated that he had been having "fits" since infancy. These continued until he was six years old. Each attack was accompanied by a period of unconsciousness which was of several minutes' duration. After the age of six, he had as many as six seizures a day. At such times as the patient experienced a "fit," he became weak and had to steady himself against some object to keep from falling. At the age of thirteen, he fell from a horse and for two weeks subsequently was blind, although he could distinguish light from darkness. After the age of sixteen, seizures were less frequent but became more frequent following induction into the Army.

He was graduated from high school at twenty-two years of age. For several years prior to Army induction he was engaged in construction work.

At the present time, he is overemotional; believes that people take advantage of him; yet he is alert and cooperative. Psychological examinations show evidence of deterioration similar to that found in organic brain lesions.

Dermatological examination revealed an acneform eruption over the nasolabial folds, cheeks, nose and forehead. There were multiple flesh colored fibromatous nodules on the left side of forehead, scalp and back (Fig. 1). A large pigmented, hairy nevus occupied the entire lumbar area (Fig. 2). Vitiligo of the left thigh and back was also present. Ophthalmological examination (Fig. 3) revealed that the pupils reacted equally to light and accommodation. Optic discs were pale and waxy. In the left eye there were multiple small, white, waxy areas which appeared adjacent to, superior and nasal to the disc. These areas resembled a colloid degeneration. The waxy granules were compatible with neurological nodules. The remaining physical examination was within normal limits.

Roentgenograms revealed multiple circular areas of increased densities with varying degrees of cotton ball calcification throughout the brain (Fig. 4 and 5). The largest calcification measured 2.25 by 1.5 cm. Calcification similar to that of the brain was also present overlying the fifth lumbar vertebra and right greater trochanter (Fig. 6 and 7). Gastrointestinal and genitourinary tracts and chest were within normal limits. Bones of the hands and

Fig. 6.

feet revealed no evidence of cystic changes. Patient refused encephalography. Urine and stool examinations were negative; blood phosphorus 2 mg., calcium 10.5 mg. per 100 cc. Red and white blood counts were within normal limits. Kahn test was negative.

Microscopic examination of the nodule from the face showed the tissue to be covered with a normal, stratified squamous epithelium, except where there was a down growth of epithelial pegs or large hair follicles. There were numerous sebaceous glands present with small amounts of connective tissue and many large hair follicles which were distended with epithelial debris.

Fig. 7.

A round cell infiltration was present around some of the hair follicles. The histological picture was compatible with a diagnosis of adenoma sebaceum.

COMMENT

Tuberous sclerosis, Recklinghausen's neurofibromatosis, and trigeminal nevus with angioma of the brain are distinct types of the neurocutaneous syndromes. Of the three, tuberous sclerosis presents the most clear-cut clinical, roentgenological and pathological picture. Furthermore, it is most constant in patients with mental retardation or epileptic seizures.

Yakovlev and Guthrie[13] believe that the neurocutaneous syndromes are due to congenital maldevelopment of ectodermal structures, namely, nervous system, retina and skin; sometimes visceral organs are involved. Penrose is of the opinion that this syndrome may be due to a single dominant gene which is subject to modification by an autosomal genetic factor.

Delay in the diagnosis of tuberous sclerosis is probably due to the physician's unfamiliarity with the syndrome because of relative scarcity in non-psychiatric institutions. Matthews[5] in a recent discussion of tuberous sclerosis states that 304 out of 335 feebleminded children were thought to have tuberous sclerosis. The diagnosis of tuberous sclerosis should be considered in every case with mental retardation, epilepsy and especially in those with adenoma sebaceum.

Symptomatology, clinical, roentgenological and pathological findings have been discussed. Visceral tumors are common and should not be overlooked. Heublein *et al.* have stated that if a renal tumor is found in the patient with mental deficiency and epileptic form of seizure, then a complete roentgen examination of the skull, including pneumo-encephalography, and dermatological consultation are warranted.

CONCLUSION

A case of tuberous sclerosis in a white soldier, aged thirty-two, has been pre-

sented. The cardinal findings in this case with a history of epileptic seizures were: adenoma sebaceum, fibromatous nodules on forehead, scalp and back, pigmented hairy nevus of the lumbar area, vitiligo of the left thigh and back, phacoma of the retina, and "cotton ball" calcifications of the brain, right greater trochanter and fifth lumbar vertebra.

We wish to express our thanks to Major Frank Duncan and Captain Ervin H. Epstein for the ophthalmological and dermatological examinations, to John Zane for the ophthalmological drawing, and to Captain Harry J. Adams, Personnel Consultant, for the psychological examination. Photographs are reproduced through the courtesy of the Signal Corps, U. S. Army.

REFERENCES

1. Berkwitz, N. J., and Rigler, L. G. Tuberous sclerosis diagnosed with cerebral pneumography. *Arch. Neurol. & Psychiat.*, 1935, *34*, 833–838.
2. Brain, R. W. Diseases of the Nervous System. Second edition. Oxford University Press, London, 1940.
3. Cecil, R. L. A Textbook of Medicine. (Stephenson, L. Tuberous sclerosis, pp. 1504–1505). W. B. Saunders Co., Philadelphia, 1942.
4. Critchley, M., and Earl, C. J. C. Tuberose sclerosis and allied conditions. *Brain*, 1932, *55*, 311–346.
5. Drake, R. L. A case of tuberous sclerosis with unusual clinical findings. *Arch. Neurol. & Psychiat.*, 1935, *34*, 681–682.
6. Globus, J. H., and Selinsky, H. Tuberous sclerosis in infant. *Am. J. Dis. Child.*, 1935, *50*, 954–965.
7. Heublein, G. W., Pendergrass, E. P., and Widmann, B. P. Roentgenographic findings in neurocutaneous syndromes. *Radiology*, 1940, *35*, 701–727.
8. Kveim, A. Ueber Adenoma sebaceum (Morbus Pringle), und seinen Platz im neurokutanen Syndrom—tuberöse Gehirnsklerose—und dessen Beziehung zur v. Recklinghausenschen Krankheit. *Acta dermat.-venereol.*, 1937, *18*, 637–683.
9. Lichstein, J., and Solis-Cohen, L. Familial tuberous sclerosis (epiloia) without adenoma sebaceum. *J. Am. M. Ass.*, 1943, *122*, 429–432.
10. Stewart, H. L. and Bauer, E. L. Tuberous sclerosis. *Arch. Path.*, 1932, *14*, 799–809.
11. Walsh, M. N., Koch, F. L. P., and Brunsting, H. A. Syndrome of tuberous sclerosis, retinal tumors and adenoma sebaceum: report of case. *Proc. Staff Meet., Mayo Clin.*, 1938, *13*, 155–160.
12. Yakovlev, P. I., and Corwin, W. Roentgenographic sign in cases of tuberous sclerosis of brain (multiple "brain stones"). *Arch. Neurol. & Psychiat.*, 1939, *42*, 1030–1037.
13. Yakovlev, P. I., and Guthrie, R. H. Congenital ectodermoses (neurocutaneous syndromes) in epileptic patients. *Arch. Neurol. & Psychiat.*, 1931, *26*, 1145–1194.

ROENTGENOLOGIC DIAGNOSIS OF PEPTIC ULCER OF THE ESOPHAGUS

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ALTHOUGH esophagoscopy has greatly increased the ease and accuracy with which the diagnosis of peptic ulcer of the esophagus may be definitely established, we believe that careful roentgenologic study is sufficiently accurate for the same purpose in many instances and that because it is far less disturbing to patients, it is the more preferable procedure. We have successfully used this preference in our practice, as will be shown later in this paper. It will be well now, however, to examine briefly and in general the question of diagnosing peptic ulcer of the esophagus.

An excellent presentation of this subject is to be found in an article by Chamberlin,[2] who offers the following diagnostic criteria:

1. The ulcer must be unassociated with systemic disease. This condition is made because of the tendency to call any ulceration of the esophagus a "peptic" ulcer, even in the presence of certain diseases in which an ulcerated mucous membrane is more likely to be a result of the disease than a separate entity.
2. The ulcer must be seen at esophagoscopy or at autopsy.
3. Free gastric hydrochloric acid must be present.
4. The ulcer must be chronic.
5. The symptoms must be relieved by peptic ulcer therapy and dilatation.

Although in our experience we have found all five of these factors important, we feel that some comment is necessary with regard to the last three.

Free hydrochloric acid will be found only in that percentage of peptic ulcers of the esophagus which irritate the acid-producing parts of the stomach. However, we can imagine finding ulcers of the esophagus which could be classified among those peptic conditions not irritating acid production and resulting, therefore, in an acidity.

Concerning chronicity, Winkelstein[6] has observed the autoptic-controlled healing of the ulcer. We regret that the definite time needed for the healing of the ulcer is not reported.

In severe cases, according to Norgaard,[4] the symptoms are pain behind the sternum or in the back initiated by swallowing, but in many cases not coming on until some time—from thirty minutes to one hour—after meals, or perhaps only after the principal meal; in addition, hematemesis, melena, dysphagia, and vomiting are present. Very often, however, the symptoms will not at all be suggestive of an affection of the esophagus. They may be entirely gastric or sometimes there may be only a slight hematemesis, without other symptoms. Obstruction seems not to occur in the early stages.

Etiologically, Jackson[2] and Chamberlin[2] point out the importance of the coincidence of ulcer and diaphragmatic hernia. Chamberlin stresses the fact that short esophagus and diaphragmatic hernia are the causes for the ulcer and thinks that cardiospasm is more likely to be a sequela of the ulcer, in contrast to the opinion of Roessler[5] who is inclined to look at it as the cause of the disease.

According to Jackson[3] the roentgen examination is usually negative in peptic ulcer of the esophagus. Possibly this is due in some cases to flatness of the ulcer and also to overlapping of diaphragmatic and hepatic shadows. In the Yearbook of Radiology[7] for 1932, in discussing the report by Aurelius[1] the abstractor writes: "Roentgenologic literature is conspicuously lacking on this subject despite the fact that cases have been definitely recognized by roentgenologic examination."

The difficulty in roentgenologic diagnosis of peptic ulcer of the esophagus is in recording changes in the lowest part of the esophagus. This is due to two conditions.

The area in which nearly all described ulcers are found is within the shadow of the diaphragm and vertebrae, or in oblique position, within the shadow of the liver. Very often irregularities in this section are seen during roentgenoscopy but cannot be found on the roentgenogram, as even a heavy barium suspension passes through this part very rapidly. Another reason is that shallow ulcers of the esophagus are often only temporarily filled.

Therefore, we have used in our studies a fluororoentgenographic device[8] as described in a former publication and known under the name of "spot film." We examine the patient at first in the routine manner, then use a fluororoentgenographic device which permits recording esophageal changes during roentgenoscopy. By this means we have been able to find without difficulty or loss of time the exact angle in which the niche in the esophagus can be projected free from any disturbing shadow. In addition, we make the exposure while the patient is in deep inspiration, thus projecting the lesion free from the opacity of diaphragm and liver.

The occurrence of peptic ulcers in the gastrointestinal tract outside the stomach and duodenum is comparatively rare. Peptic ulcers of the esophagus belong to these rare conditions. As this condition is of sufficient clinical importance, we are reporting 2 such cases.

Peptic ulcers of the esophagus have been known since Quincke in 1879 showed that the pathological changes in the esophagus were the same as those in the stomach and duodenum. The diagnosis of this condition can be made in two ways, either by direct examination or by roentgenological examination. The greatest number of cases seen by direct examination is reported by Jackson, who observed 88 cases, 21 of which were active ulcers. Other articles describe one or a few cases. Without doubt diagnoses are most accurate when made by direct visualization of the process. Esophagoscopy, however, is a procedure which causes the patient great discomfort and it should be performed only by those skilled in its technique. Our object is to show that careful roentgenological examination can demonstrate the lesion with sufficient accuracy.

Case 1. For fifteen years the patient has experienced constant burning retrosternally, localized to an area about the size of a half dollar, in the region of the xiphoid process. There was

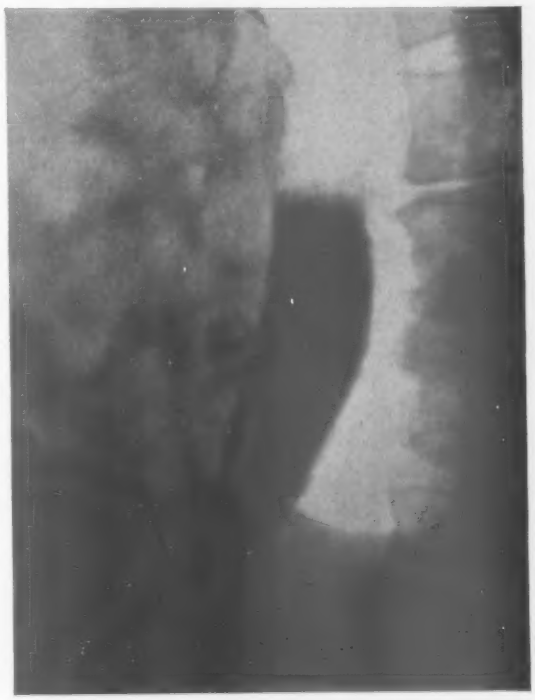

Fig. 1. Case 1. Ulcer of the esophagus, proved by esophagoscopy.

no vomiting; relief was obtained with bicarbonate of soda. At the same time her appetite was excellent and her weight was 220 pounds. About one year ago she began to vomit immediately following two or three swallows of food. At this time the burning occasionally disappeared. The vomitus was undigested material, never blood. She vomited only food, liquids being retained. At present she is able to retain only liquids. During the last three years she has lost weight, especially during the last six months. Her appetite is still excellent, no weakness, feels stronger than when she was heavier.

Roentgenological examination showed the esophagus to be of normal width. There is a slight spasm about 1 inch above the diaphragm.

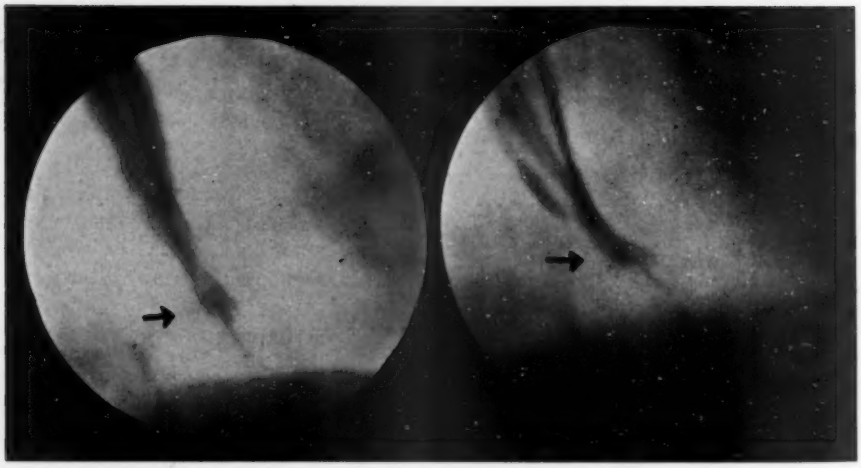

Fig. 2. Case 1. Fluororoentgenogram. The shallow ulcer is projected free from the shadow of the diaphragm. Right oblique position.

The borders of the esophagus are smooth. The mucosa shows puckering in its lower third. At the lower pole of the esophagus there is a constant patch. The passage through the esophagus is slightly delayed. However, two glasses of barium pass through. In the right oblique supine position the stomach is entirely below the diaphragm. In the left oblique position the folds of the stomach can be seen above the diaphragm. In the upright position, especially in the left oblique, the mucosa of the stomach can be seen 1 inch above the diaphragm.

Roentgen diagnosis: sliding diaphragmatic hernia; peptic ulcer of the esophagus.

Findings of the esophagoscopy by Dr. Abraham Shorr: The mucous membrane of the entire esophageal wall shows evidence of a chronic inflammatory change. There is a definite thickening near the second constriction of the esophagus. The esophagus was patent throughout its length. No evidence of tumor masses. There was a definite ulcerated area 2 mm. below the diaphragmatic pinch-cock and 2 mm. above the terminal portion of the esophagus.

Impression: Chronic esophagitis. Peptic ulceration of esophagus with spasm.

Case II. This patient, aged fifty-two, had complained of substernal pains and heartburning for the last twenty years. Her appetite was always good. She had no nausea, no vomiting. These burning pains occurred frequently

Fig. 3. Case 1. Fluororoentgenogram. Left oblique position.

Fig. 4. Case II. Fluororoentgenogram of the esophageal ulcer; star formation.

and were especially strong at certain times. She had the subjective sensation that food would stay in back of the sternum for about a minute before it would pass into the stomach. When pains were severe, she lost several pounds but always regained her weight. She never had any vomiting of blood.

The first examination in the spring of 1939 showed that the normal barium mixture passed the lower part of the esophagus in only slightly delayed time. Irregular contractions were seen. The lower part of the esophagus showed abnormal contractions, and the width of the esophagus was only slightly increased. A reexamination in February, 1940, showed that the patient had lost no weight and felt strong. The sticking pains, which had decreased occasionally under treatment with alkali, had recurred during the last three weeks. The patient was well nourished.

The roentgenologic examination showed only slightly delayed passage through the lower part of the esophagus with a thin mixture. The mucosa of the esophagus was normal. Just above the cardia the esophagus was not dilated normally. With heavy barium mixture, however, irregular contractions could be seen. Special roentgenograms of this region showed a niche in star formation as soon as the esophagus had contracted, and the main portion of the barium had been emptied into the stomach. The importance of this observation is that the niche

Fig. 5. Case II. Esophageal ulcer.

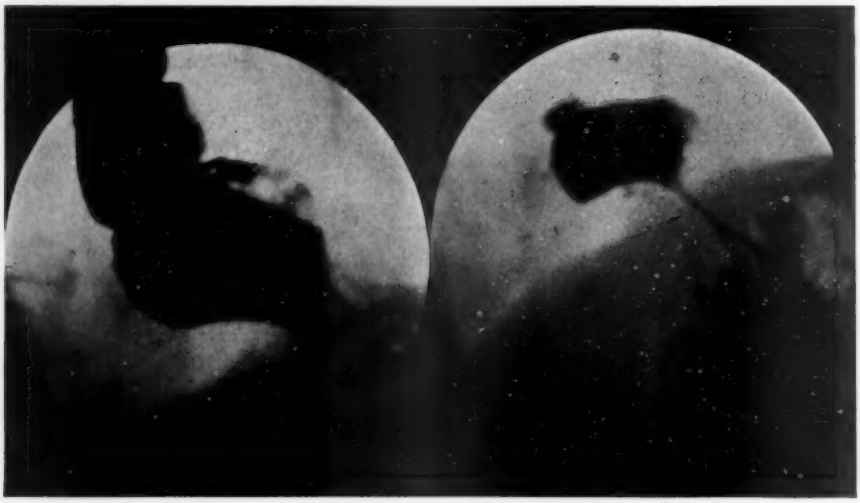

Fig. 6. Case II. The lower pole of the esophagus. The ulcer is hidden by large amount of barium.

could only be demonstrated after the bulk of the barium had been emptied, which proves that we were dealing with a superficial ulceration which had not developed into scar tissue. Here again the lesion could only be demonstrated after very deep inspiration. The fluororoentgenographic device enabled us to demonstrate the peptic ulcer. Autopsy was not performed.

DISCUSSION

The importance of the first case lies in the fact that careful roentgenologic examination was able to show a niche just above the cardia at the rear wall of the esophagus. This small niche, however, was not always visible. In certain positions the niche did not fill. In horizontal position we were not able to demonstrate the ulcer; however, in upright position while the patient was in deepest inspiration the niche could be seen several times. During examination when a large amount of barium was taken, the lower portion of the esophagus showed a spastic contraction. This spasm was the first symptom to draw our attention to the need for a more careful study and led us to the discovery of the niche at the rear wall of the esophagus. In order to verify the roentgenologic diagnosis, direct observation by Dr. Shorr was performed. It corroborated our findings.

The difficulty in finding these shallow ulcers in the lower part of the esophagus is very great. The niche does not retain the barium all the time and, therefore, can only be demonstrated temporarily. It is therefore possible that an esophageal ulcer might easily be overlooked.

We believe that in the second case we were also dealing with an esophageal ulcer, even if we have not the confirmation by esophagoscopy. We find on special roentgenograms a niche toward which three folds are radiating, giving the typical star formation of an ulcer. In this case again, by observation under full filling and after barium passage, we were able to see the lesion. The importance of the examination in "floating rotation," as emphasized by H. H. Berg, is of the greatest value, for otherwise the lesions cannot be demonstrated and fluororoentgenographic examination is of great importance for the study of the lower part of the esophagus. By this method, we were able to take roentgenograms at the necessary angle, in the moment of the barium passage, and see on the fluoroscopic screen just the outline which we record on the film.

Chronic substernal pains which are not due to heart or vascular disease are significant of peptic ulcer in the lower part of the esophagus. A careful study of such patients, who up to now were very often considered to be neurotic, might reveal a large number of cases belonging in this category.

SUMMARY

(1) Two cases of peptic ulcer of the lower part of the esophagus are described. The difficulty of the roentgenological diagnosis of these apparently not very rare conditions is described and the fluororoentgenographic study of these conditions is suggested.

(2) The main clinical signs of peptic ulcer of the esophagus are retrosternal pains and heart burn. Spasm and hematemesis are only secondary conditions in advanced cases.

REFERENCES

1. Aurelius, J. R. Peptic ulcer of esophagus. Am. J. Roentgenol. & Rad. Therapy, 1931, *26*, 696–703.
2. Chamberlin, D. T. Peptic ulcer of esophagus. *Am. J. Digest. Dis.*, 1939, *5*, 725–730.
3. Jackson, C. Peptic ulcer of the esophagus. *J. Am. M. Ass.*, 1929, *92*, 369–372.
4. Norgaard, Flemming. Peptic ulcer of esophagus. *Acta radiol.*, 1938, *19*, 458–464.
5. Roessler, W. Ueber das Ulcus pepticum oesophagi. *Deutsche Ztschr. f. Chir.*, 1935, *145*, 333–358.
6. Winkelstein, A. Peptic esophagitis. *J. Am. M. Ass.*, 1935, *104*, 906–909.
7. 1932 Year Book of Radiology. Year Book Publishers, Chicago.
8. Lust, F. J. The fluororoentgenograph. Am. J. Roentgenol. & Rad. Therapy, 1940, *43*, 141–142.

THE NORMAL DISTRIBUTION OF THE SMALL INTESTINE*

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ACCURATE knowledge of the normal anatomic position of the numerous and tortuous loops of small intestine, if such a normal distribution exists, would be of great value to the roentgenologist and surgeon since it would enable them to localize disease of the small intestinal tract with some degree of confidence. They could determine the exact level of small intestinal obstruction, predict what loops were to be found in the various types of hernial sacs, and locate with some degree of dependability the level of small intestinal new growths, ulcerations, inflammations and adhesions. In view of the great value of such knowledge, it is rather remarkable that so little work has been done in this field in recent years.

Prior to the work of Treves[7] (1885), of Henke[3] (1891), and of Mall[5] (1898), it was generally believed that there was no such thing as a normal position of the small intestine. Most anatomists took for granted that these tortuous coils moved about the abdomen from quadrant to quadrant, rarely staying in any one place for any length of time. However, in 1898 Mall proved that this was not the case. He demonstrated in dogs that loops of small bowel had certain definite positions to which they returned if experimentally displaced. To do this, he operated on dogs, opened the peritoneal cavity and displaced a loop of small bowel. Several days later upon reopening these animals he found that the displaced loop had returned to its original position. This work was confirmed by Hertzler[4] in 1913. There is, therefore, some experimental evidence for the belief that there is a constant distribution of small intestine, at least in the same individual. Whether there is a constant arrangement when we compare one individual to another is a different matter, and one which deserves further consideration.

In 1885 Treves, in an attempt to help the surgeon locate the many loops of small intestine, started the work on this subject. He studied 100 freshly autopsied bodies. He fixed brass tags to visible loops of the small intestine and then traced the position of these loops in relation to the quadrants of the abdomen. The intestine was removed and the distance of the various brass numbers from the duodenum was noted. The summary of the work can best be given in one of Treves' opening sentences. "The work was laborious, the results were scanty." He felt that definite localization of the loops of small intestine to quadrants of the abdomen was not possible. For example, in the pelvis it was not unusual to find loops lying together that were as much as 12 feet apart. Extremes in the left iliac region were from 2 feet to 23 feet; the right iliac region from 9 feet to 28 feet; and the left lumbar region a few inches to 15 feet. He found that the position depended upon the size and shape of the surrounding organs, especially the stomach and colon. In one case of carcinoma of the pylorus, where the stomach was tremendously enlarged, all but 3 feet of the small intestine was found in the pelvis. He pointed out that the intestine was disposed in an irregularly curved manner from the left upper quadrant to the right lower quadrant. He discounted, however, the value of this arrangement as an aid to the surgeon.

In 1891, Henke continued the work on this problem. He is given credit by Mall for making the first real attempt to locate the position of the small intestine. Henke divided the abdomen into four compartments: subdiaphragmatic, pelvic, right and left lumbar. With these divisions in mind

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he located the various loops of small intestine in 3 cadavers, but could come to no definite conclusions. In view of the small number of cases studied, and the complexity of the problem, this is not at all surprising. He did note, however, that the course of the loops on the right side of the abdomen tended to be vertical, whereas the course on the left was horizontal.

In 1894 Sernoff[6] attempted to clarify the work of Henke. He hardened the intestines with chromic acid, and when they became fixed in position he made casts of the hardened coils. He was unable to come to any conclusion as to a normal pattern of arrangement. In 1896 Weinberg,[8] using the method described by Sernoff, studied the small intestine of newborn infants rather than adults, but like Treves, Henke and Sernoff who preceded him, his results were inconclusive.

It was not until 1898 that a working conception of the normal position of the small intestinal coils was elaborated by Mall. He attacked the problem from both the embryologic and anatomic viewpoints. This enabled him to grasp the difficult problem much more easily than any of his predecessors. He found that in the very early embryo he could subdivide the small intestine into six segments. He watched the development of these segments into loops and coils as he followed them from the smallest embryo to the newborn infant. Thus, having an embryologic basis from which to work, and a general concept of the nature of the development, he could attack the problem more comprehensively. For this purpose, he studied 41 cadavers which had been fixed in phenol. Bodies which showed evidence of peritoneal adhesions were not included. In 21 of these 41 cadavers, he found what he considered to be the normal distribution of the small intestine (Fig. 1).

Loop 1 (the duodenum) was relatively constant.

Loops 2 and 3 were confined to the left upper quadrant.

Loop 4 passed through the midline at about the level of the umbilicus to the right upper quadrant and then recrossed the midline to the left lower quadrant, where it became loop 5.

Loop 5 then descended into the pelvis and became loop 6.

Loop 6 filled the pelvis, the right iliac fossa and the lower abdominal cavity.

It should be noted that in spite of the fact that Mall established this normal position, only 21 of 41 cadavers, or 50 per cent of the cases studied, adhered to the pattern.

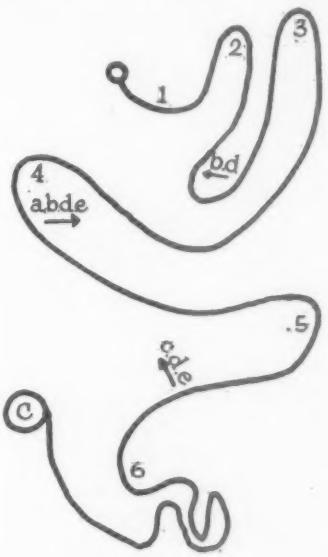

Fig. 1.

The other 20 cases were arranged as shown by the arrows in Figure 1.

Hertzler (1919) studied 1,187 cadavers in which he traced the small intestinal coils after the method of Mall. He found that 75 per cent of the cases studied showed the "normal" arrangement described by Mall. He felt, however, that regular as the arrangement of the small intestinal coils may be "it is not sufficiently so to meet the requirements of the surgeon; since he must recognize the segment of gut at best through a small incision."

In 1927 the problem was attacked from the roentgenographic standpoint by The Cole Collaborators.[2] After following the course of barium through the small intestine in a great number of cases, they found what they believed was the normal config-

uration of the small intestine. This they felt substantiated Mall's findings. From similar roentgen studies, however, Chamberlin[1] (1939) was unable to confirm this work. He felt the variations were too numerous to establish any normal distribution of intestinal coils.

It is obvious from the preceding summary of the past work, that there is no general agreement on this problem. Since many of the standard textbooks of anatomy accept Mall's findings, and since some roentgenologists today base their work on these results, it was decided to re-investigate the problem.

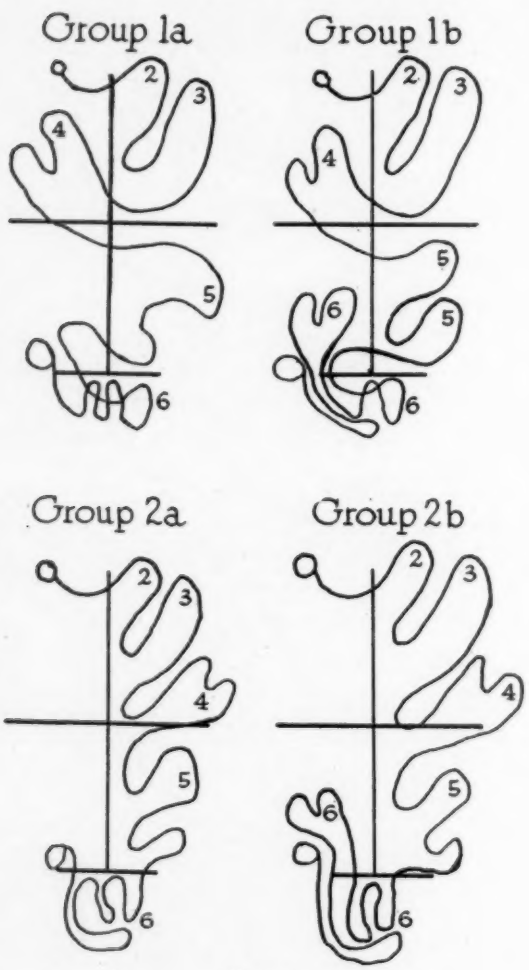

FIG. 2.

METHOD

Fifty-four cadavers were studied. The habitus of each was determined by tracings of the subcostal angle. The series was divided arbitrarily into three groups: hypersthenic, sthenic and hyposthenic, depending upon the nature of this angle. The abdomen was divided into five regions: right upper quadrant, right lower quadrant, left lower quadrant, left upper quadrant, minor pelvis. The supracristal plane was used to separate the upper from lower quadrants. A loop of small intestine was selected at random from each of the five regions and was identified by tying a colored ligature about it, different colors being used for each region. In 5 of the cadavers instead of choosing a loop at random, *all* the loops in each region were identified by colored strings. Thereafter, a schematic drawing of the configuration of the small bowel with a particular reference to the five regions was made. The small intestine distal to the duodenojejunal flexure was removed by cutting the mesentery at its attachment to the gut. The total length of the specimens was measured, and the distance of each colored ligature from the duodenojejunal flexure was determined.

FINDINGS

An attempt was made to classify the cases studied according to the plan described by Mall, but too many variants were encountered so that it was necessary to modify his basic groups. They were reclassified as follows (see Fig. 2 and 3):

Group (1a) This group corresponds to the "normal" described by Mall. Loop 1 (duodenum) is relatively constant. Loops 2 and 3 fill the left upper quadrant. Loop 4 passes through the midline at about the level of the umbilicus to the right upper quadrant; then recrosses to the left lower quadrant to become loop 5. Loop 5 descends into the pelvis to become loop 6. Loop 6 fills the pelvis. The terminal ileum then ascends to the cecum.

Group (1b) This group corresponds to variation (c) of Mall. It is the same as (1a) except that loop 6 ascends from the pelvis to help fill the right lower quadrant.

Group (*2a*) This group corresponds to variation (a) of Mall. Loop 4 instead of occupying the right upper quadrant is found on the left side. No small intestine is present in the right upper quadrant (except duodenum).

Group (*2b*) This group corresponds to variation (e) of Mall. It is the same as (2a) except that loop 6 ascends from pelvis to help fill the right side of the abdomen.

Group (*3a*) This group corresponds to variation (b) of Mall. Loops 2 and 3 cross immediately to the right upper quadrant, and loop 4 takes their place on the left side of the abdomen. This is a heterogeneous group in which there are many minor variations.

Group (*3b*) This group corresponds to variation (d) of Mall. It is the same as group (3a) except that small intestine ascends from the pelvis to fill the right lower quadrant.

Group (*4a*) This group does not correspond to any in Mall's series. Loop 4, instead of recrossing to the left, descends directly into the pelvis where it remains with loops 5 and 6.

Group (*4b*) This group does not correspond to any in Mall's series. This is the same as (4a) except that gut arises out of the pelvis to fill the left lower quadrant.

Each of the (b) groups differs from its respective (a) group merely in that portions of the small intestine rise out of the pelvis to help fill the lower quadrants. It is obvious that these variants may be dependent upon certain physiologic and pathologic conditions, such as distended bladder or rectosigmoid, enlarged uterus, tumor masses, etc.

Group (*5*) has no corresponding group in Mall's description. This is a group of 3 cases in which the jejunum (loop 2 and 3) descends to the pelvis and loops 4, 5 and 6 fill the pelvis from which they ascend to fill the lower quadrants. This group is unusual in that they are the only cases in which the terminal ileum came down to meet the cecum from above, rather than ascending from the pelvis to do so.

There was one isolated case which could not be placed into any of the preceding groups. In this cadaver there was no small bowel in both upper quadrants. The duodenojejunal junction was in the left lower quadrant and most of the small intestine was found in the pelvis. The number of examples of each group are given in Table 1, and the findings are compared with those of Mall.

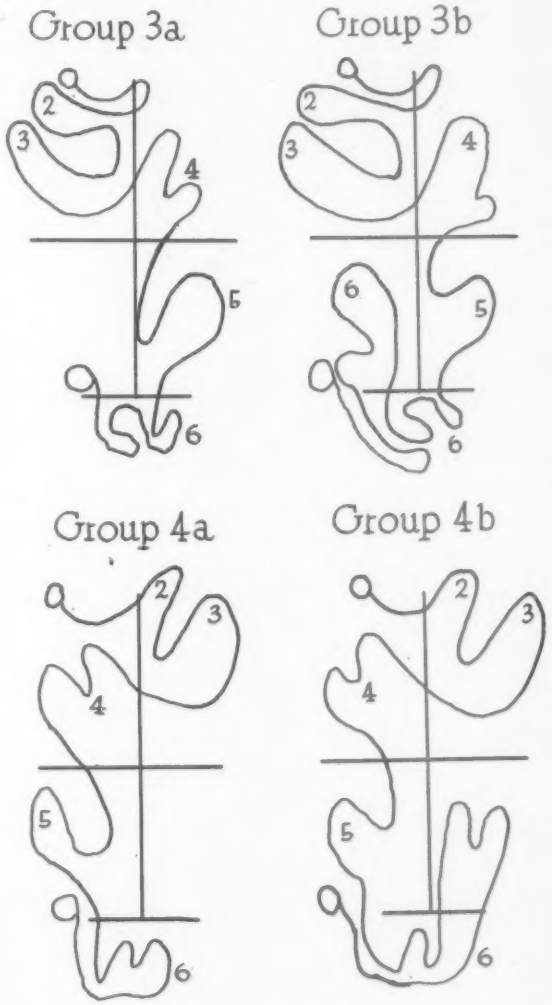

Fig. 3

It was expected that some relationship might be found between these various groups and their habitus, but this was not the case. There is a slightly greater tendency for small intestine to be absent from the right upper quadrant in hyposthenic in-

Table I

Group		Frequency		Per Cent	
This Study	Mall	This Study	Mall	This Study	Mall
1a	normal	7	21	13	50
1b	(c)	5	5	9	13
2a	(a)	5	6	9	15
2b	(e)	12	1	22	3
3a	(b)	12	6	22	15
3b	(d)	0	2	0	5
4a		7	0	13	0
4b		2	0	4	0
5		3	0	6	0
Unusual anomaly		1	0	2	0
Total		54	41		

dividuals. Aside from this rather questionable relationship, habitus seems to play no significant part in the distribution of the small intestine.

The total length of the bowel varied from 10 to 30 feet. The average for the hypersthenic group was 19 feet; sthenic, 16.5 feet, and the hyposthenic, 15 feet. In spite of this apparent association, many of the intestines in the hyposthenic group were considerably longer than those in the hypersthenic group, so that no definite conclusions could be drawn from so small a series of cases.

The distance of the various colored strings from the duodenojejunal junction was measured and great variations were en-

Table II

Total Length	Left Upper Quadrant (green)	Left Lower Quadrant (red)	Right Upper Quadrant (yellow)	Right Lower Quadrant (brown)	Pelvis (purple)
Case I 22 ft. 3 in.	2′ 3′ 9″ 5′ 3″	2′ 6″ 3′ 2″ 4′ 5′ 9″	6″ 6′	1′ 4″ 9′ 2″ 22′ 2″	4′ 7″ 6′ 5″ 11′ 4″ 14′ 1″ 17′ 6″
Case II 11 ft.	7″ 1′ 1′ 2″ 2′	1′ 10″ 3′ 4′ 4′ 7″	5″ 2′ 6″ 7′	6′ 6′ 10″ 7′ 4″ 8′ 2″	3′ 6″ 8′ 7″ 9′ 9′ 11″ 10′ 9″
Case III 30 ft. 1 in.	3″ 1′ 3″ 2′ 6″	1′ 9″ 3′ 9″ 6′ 2″ 9′ 9″ 12′ 1″	20′ 6″ 22′ 1″	4′ 11″	7′ 3″ 13′ 1″ 19′ 6″ 23′ 7″ 24′ 2″ 29′ 10″
Case IV 18 ft.	1″ 5″ 5′ 9″	3′ 9″ 4′ 3″ 4′ 8″ 7′ 10″	12′ 6″	1′ 3″ 11′ 4″ 14′ 3″	9′ 9″ 16′ 2″ 17′ 2″ 18′
Case V 14 ft. 6 in.	6″	3″ 10″ 1′ 2″ 1′ 6″		6′ 3″ 13′ 11″ 14′ 11″	3′ 1″ 3′ 8″ 5′ 3″ 9′ 12′ 3″ 12′ 9″

countered. For example, the red string which signified the left lower quadrant was found to be 2 feet 6 inches from the duodenojejunal junction (12 per cent total length of small intestine) in one cadaver and 15 feet (75 per cent total length) from the same point in another. Similar variations were encountered in other regions.

In the 5 cadavers in which many strings were tied in each region, loops were found lying together which in the outstretched gut were as much as 20 feet apart (Table II).

CONCLUSIONS

1. Although, as Mall indicated, definite patterns and groups are recognizable in a study of the small intestine, these are not sufficiently constant to be of any clinical value.

2. Unlike Mall's series, no predominant group is to be found.

3. There is no relationship between any of these groups and their habitus, so that there is no way to determine beforehand what group we are dealing with.

4. It is impossible to predict the distance of a loop from the duodenojejunal junction by its location in the abdomen. There is, therefore, no anatomic basis for hoping that one can localize the distance of a small intestinal lesion from the duodenojejunal junction by its position in the peritoneal cavity.

The authors wish to express their appreciation to Dr. Donal Sheehan for his helpful suggestions and criticisms.

REFERENCES

1. CHAMBERLIN, G. W. Roentgen anatomy of small intestine. *J. Am. M. Ass.*, 1939, *113*, 1537–1541.
2. COLE, LEWIS GREGORY, and others. Radiologic Exploration of the Mucosa of the Gastro-Intestinal Tract. By The Cole Collaborators. Bruce Publishing Co., St. Paul, 1934.
3. HENKE, W. Der Raum der Bauchhöle des Menschen, und die Vertheilung der Eingeweide in demselben. *Arch. f. Anat. u. Entwcklngsgesch.*, 1891, *1*, 89.
4. HERTZLER, A. E. The Peritoneum. C. V. Mosby Co., St. Louis, 1919.
5. MALL, F. P. Development of the human intestines and its position in the adult. *Johns Hopkins Hosp. Bull.*, 1898, *9*, 197.
6. SERNOFF, D. Zur Kenntnis der Lage und Form des mesenterialen Teiles des Dunndarmes und seines Gekröses. *Internat. Monatschr. f. Anat. u. Physiol.*, 1894, *11*, 437.
7. TREVES, F. Lectures on anatomy of the intestinal canal and peritoneum in man. *Brit. M. J.*, 1885, *1*, 415.
8. WEINBERG, R. Topographie der Mesenterien und der Windungen des Jejuno-ileum beim neugeborenen Menschen. *Internat. Monatschr. f. Anat. u. Physiol.*, 1896, *13*, 66.

THE POSITION OF THE SMALL INTESTINE AS DETERMINED ROENTGENOGRAPHICALLY

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THE primary purpose of this study was to determine whether the distribution of the small intestinal loops in the living varied in any way from that found in the cadaver.

One hundred adult individuals were studied serially after the ingestion of 250 cc. of barium sulfate suspension, with 14 by 17 inch films in the prone posture at fifteen minute intervals for the first two hours and at thirty minute intervals thereafter until the barium reached the cecum. It was not as easy to trace the course of the barium-filled loops in the living as it was to trace the loops in the cadaver. It was therefore impossible to classify the results into as many anatomical groups as described in the preceding cadaver study.[1] Instead, it was decided to subdivide the 100 cases into three groups on the basis of certain definite positional characteristics. Age, sex and habitus were not found to be factors in the determination of these groups.

Group (1): Consisted of those cases in which loops 2 and 3 were on the left side of the abdomen and in which loop 4 crossed to the right upper quadrant. There were 49 such cases.

Group (2): Consisted of those cases in which there was no small bowel present in the right upper quadrant. There were 31 such cases.

Group (3): Consisted of those cases in which loop 4 was absent from the right upper quadrant and in its stead either loop 2 or loop 3 or both replaced it. This resulted in early crossing of the small bowel to the right upper quadrant. There were 20 such cases.

When the 54 dissected cadavers described in the previous paper[1] were reclassified on this basis there was noted a striking similarity in percentages:

	Roentgen Study per cent	Cadaver Study per cent
Group (1)	49	42
Group (2)	31	33
Group (3)	20	25

CONCLUSIONS

On the basis of our comparative study, it can be stated:

(1) that no significant changes take place in the position of the small intestinal loops after death;

(2) that it is impossible to determine roentgenographically the distance of any small intestinal lesion from the duodenojejunal junction from its location in the abdomen, except for those obviously very near to the duodenojejunal junction;

(3) that it is impossible to classify the position of the intestinal loops on as complete a basis as is possible by dissection of the cadaver, and that even if it were possible, it would have no clinical application because of the great variability.

[1] Herstone, S. T., and Freund, S. Normal distribution of the small intestine. AM. J. ROENTGENOL. & RAD. THERAPY, July, 1944, *52*, 46–51.

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SPINAL EXTRADURAL CYST (DIVERTICULUM OF SPINAL ARACHNOID)

REPORT OF A CASE

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IN 1934, Elsberg, Dyke and Brewer reported 4 cases of spinal extradural cyst with compression of the spinal cord. Previous to their report most of the extradural cysts recorded in the medical literature were either dermoids or due to echinococcus. They concluded that they were dealing with a definite clinical entity which they described as follows:

The individual is an adolescent with the history and symptoms of a progressive spastic paraplegia. Pain is absent or is not a prominent symptom. The objective disturbances of sensibility are slight and their upper level is in the mid-thoracic region, usually at the sixth or seventh thoracic dermatome. The manometric tests demonstrate a subarachnoid block with characteristic spinal fluid changes of cord compression. Measurements on anteroposterior x-ray films show that the interpedicular spaces of three or more vertebrae somewhere between the fourth and the tenth thoracic vertebrae are enlarged. The pedicles of the affected vertebrae especially those of the sixth, seventh and eighth, are narrowed and atrophic.

In 1937 Cloward and Bucy demonstrated that, with one exception, all reported cases of spinal extradural cyst which gave rise to symptoms during adolescence were associated with deformities of the thoracic portion of the spinal column, usually kyphosis of the type seen in Scheuermann's disease, and often referred to as vertebral epiphysitis.

In 1941 Adelstein reviewed the existing literature on the subject and collected data on 17 cases of spinal extradural cyst, including an unreported case of his own. We have found the following cases reported in the literature in addition to those listed by Adelstein: 1 reported by Turnbull in 1939, 1 by Meredith quoted by Mayfield and Grantham and an additional case included by Mayfield and Grantham in 1942. Therefore, the report of a case which follows apparently represents the twenty-first instance of this interesting condition to be recorded. Our case is especially interesting because of the fact that our patient is older than most (only 2 patients listed by Adelstein were older) and because the communication of the cyst with the subarachnoid space was demonstrated preoperatively during the course of the roentgenologic examination following introduction of radiopaque oil into the lumbar subarachnoid space.

REPORT OF CASE

A man, aged forty-two, first came to the Mayo Clinic in September, 1941, because of weakness in the left lower extremity. He could not remain to complete his examination and was not seen again until April 19, 1943. Except that he had been "round-shouldered" since the age of fifteen years, and that he had experienced "rheumatic pains" in the left hip at the age of eighteen years, he had been entirely well until the onset of his present illness.

In 1933, at the age of thirty-four, the patient had begun to complain of "clumsiness" of the left foot and leg associated with a "stiff feeling" involving the toes and plantar surface of the

foot. This weakness and stiffness progressed slowly, so that by 1938 the entire left lower extremity was involved. At this time he began to experience similar sensations in the right foot and leg. It was not until his examination in 1941 that he realized that there was actual sensory loss in the lower extremities. At no time had there been disturbance of sphincteral control.

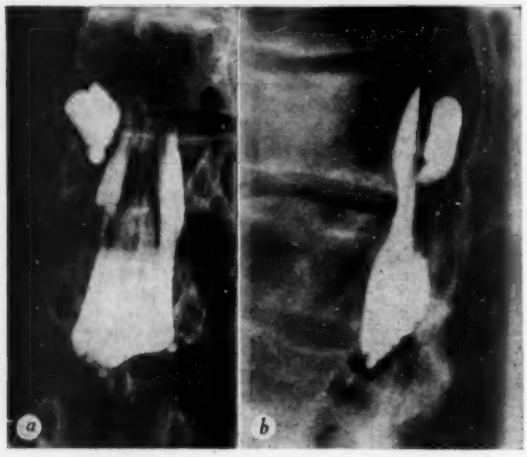

FIG. 1. *a*, posteroanterior roentgenogram made with patient's head lower than his feet. The radiopaque oil is blocked opposite the eleventh thoracic interspace and there is an extradural collection of oil on the left. Erosion of the pedicles of the eleventh and twelfth thoracic vertebrae is shown. *b*, lateral view showing the posterior location of the extradural oil. The slight wedging of the bodies of the lower thoracic vertebrae is similar to the changes seen in kyphosis dorsalis juvenilis.

Our examination in 1941 disclosed a Brown-Séquard syndrome on the left side below the first lumbar segment. Loss of strength, amounting to 50 or 60 per cent, and atrophy of the muscles supplied by the second to the fifth lumbar and the sacral nerves were noted on the left. There was also slight loss of strength of the muscles supplied by the nerves from the eighth thoracic to the first lumbar. Sensory loss was limited to the fifth lumbar and first sacral dermatomes. The sensations of pain, temperature and pressure were decreased about half, while the vibratory and proprioceptive sensations were somewhat less affected.

The sensory level on the right extended up to and included the first lumbar dermatome. The changes were less marked for the first and second lumbar segments than for those lower down.

Deep reflexes were hyperactive on both sides, those on the left being greater than those on the right. Babinski, Chaddock and Mendel-Bechterew signs were present bilaterally. The right cremasteric reflex was decreased, while the superficial abdominal reflexes were normal.

Lumbar puncture on September 23, 1941, disclosed incomplete subarachnoid block with 30 mg. of total protein and 2 cells per cubic centimeter of cerebrospinal fluid.

At the time of the patient's second visit, in 1943, the findings on neurologic examination were about the same, except for additional weakness of the right lower extremity.

Roentgenograms of the lower thoracic and lumbar regions showed eroded pedicles of the eleventh and twelfth thoracic vertebrae. Very minor changes in the bodies of the lower thoracic vertebrae similar to those found in kyphosis dorsalis juvenilis are noted in retrospect. Five cubic centimeters of radiopaque oil were introduced into the lumbar subarachnoid space and a roentgenoscopic examination carried out. With the table tilted so that the patient's head was lower than his feet a complete block to the flow of opaque material was encountered opposite the eleventh thoracic interspace. At the same time it was noted that some

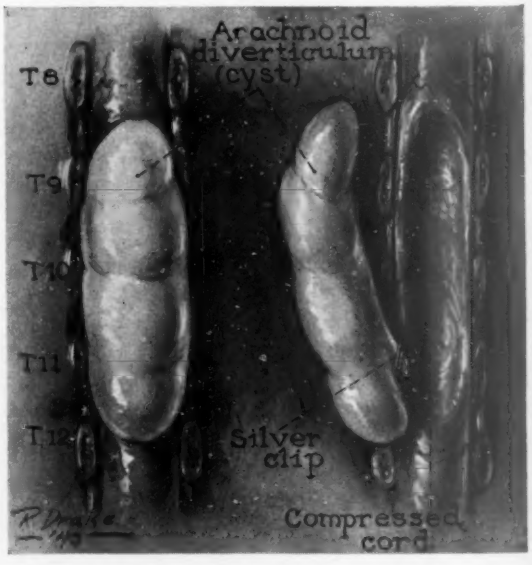

FIG. 2. The cyst, its relation to the cord and its communication with the subdural space.

of the radiopaque oil collected outside the usual limits of the subdural space (Fig. 1, *a* and *b*). This collection was on the left side opposite the eleventh thoracic interspace, and was shown to be posterior to the cord by examination in the lateral and oblique positions.

Immediately after contrast myelography bilateral laminectomy was begun. With the patient under ether anesthesia the spines and arches of the eighth, ninth, tenth, eleventh and twelfth thoracic vertebrae were removed. A thin-walled cyst was disclosed, lying posterior to the cord, and extending from the eighth thoracic to the first lumbar vertebra (Fig. 2). It was easily separated from the underlying dura except at one point of attachment on the left side opposite the eleventh thoracic nerve root. The cyst communicated with the subarachnoid space of the spinal canal. It then became apparent that the cyst was a diverticulum of the spinal arachnoid. The cyst was inadvertently opened, and radiopaque oil and cerebrospinal fluid were seen to escape.

The cyst, which measured 7 cm. in length and 2 cm. in width, was removed after the neck, which communicated with the spinal arachnoid, had been closed with a silver clip. The defect in the dura was closed with a silk suture. Roentgenograms of the partially deflated cyst showed it to contain radiopaque oil (Fig. 3) and the pathologist reported the wall of the cyst to be made up of arachnoid membrane.

The patient's postoperative course was uneventful. Immediately after the operation, there was no material change in the motor and sensory functions, but as time has elapsed, gradual improvement has been observed.

COMMENT

In most of the reported instances of spinal extradural cyst the patient has been in the adolescent age group. Including our case, only 3 patients were older than twenty-six years of age, and the majority have been less than twenty years of age. Male patients outnumber female patients four to one. Symptoms have been present for as short a period as three months and for as long as twelve years. Almost all of the cysts have been located in the middle or lower thoracic region. In Meredith's case the cyst was reported to be in the cervical region and in 2 other cases, though it originated in the lower thoracic region, it extended into the lumbar region.

Since the cysts originate laterally near the emergence of a spinal nerve root the symptoms of weakness and spasticity at the onset frequently are noted in the lower extremity on the same side. Soon after this, the opposite lower extremity is affected. This paraplegia is accompanied by a sensory level which is frequently indistinct. Disturbance of sphincteral control may or may not be present. Pain is usually absent. Remission of symptoms may occur spontaneously or after orthopedic measures directed at relieving the dorsal kyphosis.

Fig. 3. Roentgenogram of cyst after removal. Some of the radiopaque oil remains within the partially deflated cyst.

If consideration is given only to the history and physical examination, a diagnosis of multiple sclerosis or other degenerative process may be considered. Examination of roentgenograms of the spinal column, however, and the results of lumbar puncture will soon reveal the true nature of the lesion. Manometric tests often show either partial or complete block to the flow of cerebrospinal fluid, and an increase of the total

protein content of the spinal fluid may be noted.

Roentgenograms may show changes which are pathognomonic. Enlargements of the spinal canal, together with the changes of kyphosis dorsalis juvenilis in the bodies of the involved vertebrae are not found in any other condition. If the symptoms of compression of the cord begin after the bony development of the vertebral column is complete, the changes of kyphosis dorsalis juvenilis do not occur. Cloward and Bucy have reported 1 such case. The pedicles of more than one vertebra show erosion of their inner margins, and these changes may extend for the entire length of the cyst. As was noted in our case, radiopaque oil introduced into the lumbar subarachnoid space may demonstrate the extradural character of the cyst in addition to the usual signs of tumor. Demonstration by means of radiopaque oil of the communication between the cyst and the subarachnoid space has been reported previously by Teachenor and by Elsberg, Dyke and Brewer (Case 3).

Probably the most important factor in arriving at the diagnosis by means of the roentgenologic examination is to remember that such a condition exists. In our case all of the signs were present, although the evidence of kyphosis dorsalis juvenilis was minimal, but the true nature of the lesion was not suspected until the radiopaque oil was seen to enter the cyst at the time of the roentgenoscopic examination.

REFERENCES

1. ADELSTEIN, L. J. Spinal extradural cyst associated with kyphosis dorsalis juvenilis. *J. Bone & Joint Surg.*, 1941, *23*, 93–101.
2. CLOWARD, R. B., and BUCY, P. C. Spinal extradural cyst and kyphosis dorsalis juvenilis. AM. J. ROENTGENOL. & RAD. THERAPY, 1937, *38*, 681–706.
3. ELSBERG, C. A., DYKE, C. G., and BREWER, E. D. Symptoms and diagnosis of extradural cysts. *Bull. Neurol. Inst. New York*, 1934, *3*, 395–417.
4. MAYFIELD, F. H., and GRANTHAM, E. G. Spinal extradural cysts. *Surgery*, 1942, *11*, 589–595.
5. MEREDITH, J. M. Quoted by Mayfield and Grantham.[4]
6. TEACHENOR, F. R. Quoted by Adelstein.[1]
7. TURNBULL, F. Spinal extradural cyst. *Canad. M. Ass. J.*, 1939, *41*, 250–253.

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THE ROENTGEN INTERPRETATION OF THE PATHOLOGY IN POTT'S DISEASE*

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IN THE field of diagnostic roentgenology the classical roentgenographic appearance of Pott's disease (narrowing of the intervertebral disc, collapse of the vertebral bodies, with or without the shadow of a "cold abscess") presents as specific and as accurate a picture of the actual pathology as in any disease entity. However, during the past ten years when we have had the opportunity to study various types of tuberculous spines, we have found that the classical description, pathologically, and necessarily, therefore, roentgenographically represents only a partial picture of the disease. In a recent study[1] we have found that the roentgenogram frequently underestimates the number of vertebrae involved, and, often enough to be disconcerting, misses extensive involvement completely. It is the purpose of the present study to describe the various types of pathological changes in the tuberculous spine and to correlate the roentgenograms of these same lesions, in order to explain the discrepancies.

MATERIAL

The necropsy examination of 1,545 tuberculous patients at Sea View Hospital disclosed the presence of Pott's disease in 132 cases (9 per cent). Of these, 100 had had roentgenographic studies made of the spine, usually less than six months before death. In the following study where errors in roentgen interpretations exist, they are considered of no importance unless the roentgenograms were taken within six months of death.

AGE

The youngest individual in this group was two years old; the oldest, sixty-seven. Seventy-two cases (55 per cent) were in the second and third decades of life, an age distribution which is at variance with that usually reported in clinical studies. Wullstein's[10] compilation of his own statistics, together with those of Mohr,[6] Drachmann,[5] and Vulpius,[9] disclosed 85.3 per cent of all clinical cases of Pott's disease occurring in the first two decades of life. On the other hand, pathological studies (Brenner,[3] Billroth and Menzel[2]) reveal an age distribution similar to ours, probably because tuberculous spondylitis is a relatively benign disease, many cases undergoing healing. Those that do not, progress slowly and reach the pathologist at a much older age.

RACE

Seventy-two (55 per cent) of the 132 cases were Negroes, 57 (43 per cent) were white and 3 (2 per cent) were Chinese. Since the ratio of Negroes to whites in our general necropsy material is 4.7, this preponderance of Negroes is especially striking.

PATHOGENESIS

It is generally accepted that tuberculous involvement of the skeletal system occurs by way of the blood stream. However, the origin of the tuberculous bacillemia and the mode of localization of the organisms in the bone has been the subject of much controversy.

Since the vertebral disease is of hematogenous origin, it must result from an active tuberculous process elsewhere in the body. Accurate determination of the location of such a process is difficult since the skeletal involvement may be present for a long period before a diagnosis is made. Brenner[3] found that 45 per cent of 39 cases of tuberculosis of the spine were undiagnosed during life, although some of them showed extensive destruction of the vertebrae. Roentgenographic studies of these patients

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were not made. Of our 132 cases, 49 (37 per cent) were undiagnosed during life, although the lesion was suspected from clinical evidence in 18 of these.

The associated pathologic condition is an aid in establishing the origin of the bone lesions. There was an active chronic pulmonary process in only 35 (26 per cent) of our cases, although it seemed possible that a hematogenous dissemination from the lungs might have occurred. Most often, however, the clinical and pathological findings indicated that the skeletal tuberculosis was the older process.

Similarly, a hematogenous dissemination may occur from a tuberculous involvement of the urogenital system. The coexistence of skeletal and urogenital tuberculosis was found in 38 (29 per cent) cases. In many of these, the urogenital disease antedated the skeletal tuberculosis; in some, the opposite was true.

In 11 cases, both chronic pulmonary tuberculosis and urogenital tuberculosis were present together, which leaves 80 cases (66 per cent) in which there was no definite source of hematogenous dissemination to the spine. This leads us to believe that involvement of the skeletal system most frequently is related to the primary complex. The hematogenous dissemination occurs while the primary complex is fresh, and ceases with its healing or encapsulation. Evidence for such dissemination is found in the old hematogenous foci in the apical portions of the lungs, as well as the presence of encapsulated caseous calcified foci in the liver or spleen. The bone marrow is a frequent location for the seedings of the tubercle bacillus when the organism gains access to the blood stream. In routine sections of the spine removed at necropsy from tuberculous patients, miliary and larger foci were frequently found where generalized hematogenous seedings were found elsewhere in the body. The smaller foci tend to be entirely cellular, while the larger show central caseation. The miliary foci may go on to anatomic healing; the larger may go on to progression. When this occurs, an isolated organ disease of the vertebra results, which by its extent or contiguous involvement of the soft parts produces clinical and roentgenological signs of disease.

PATHOLOGY

Number of Vertebrae Involved. In only 6 of our 132 cases was there involvement of a single vertebra. Two vertebrae were involved in 39 (30 per cent) cases, the vertebrae being adjacent in all but one instance. In 24 cases (18 per cent) three adjacent vertebrae were involved. In the remaining 63 cases (48 per cent) multiple lesions were found. When multiple vertebrae were affected, the disease was usually, but not always, found in contiguous vertebrae. In general, destroyed vertebrae occurred contiguously, while the skipped lesions showed productive changes. The most extensive process we observed extended from the body of the fifth cervical vertebra to the coccyx.

Distribution. The lower dorsal and lumbar vertebrae were most frequently involved, followed in order of incidence by the sacral, lower cervical, and upper cervical vertebrae. There was a gradual rise in frequency of involvement from the fifth to the eighth dorsal vertebrae; a rapid rise in the lower dorsal and upper lumbar region, and a gradual fall in incidence in the lower lumbar and sacrum. Our findings are in agreement with the majority of statistics in the literature.

Location. The pathologic appearance of the bone in the early stage of the lesion indicates that the process develops first in the vertebral body, the intervertebral disc being involved by direct extension. As Cleveland and Bosworth[4] have explained, the reason for this probably lies in the anatomic character of the intervertebral joint spaces, which, lacking capsule or synovial lining, are relatively avascular. The hematogenous origin of Pott's disease would therefore appreciably diminish the chances of the disc being involved initially.

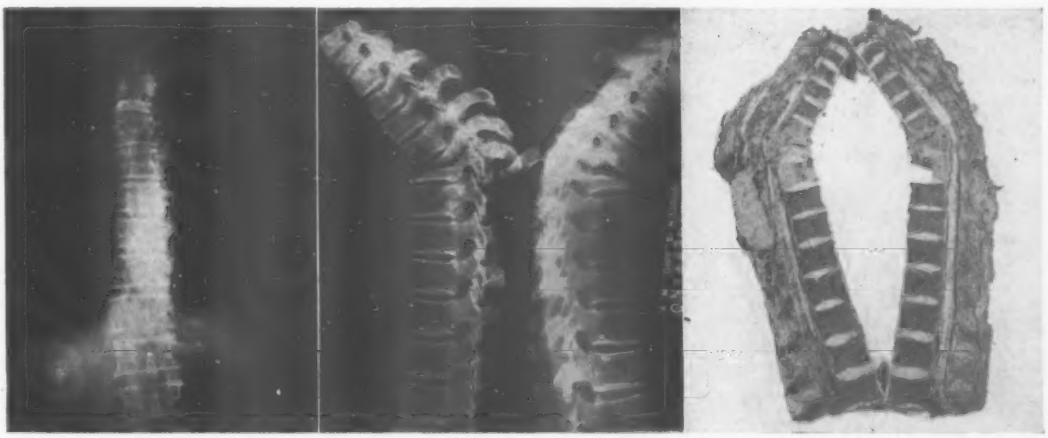
The lesion usually appears in the anterior aspect of the vertebral body, rarely in the

central, posterior portions, or in the small parts.

Gross Appearance. Recently, we pointed out[1] that the appearance of the bone may assume two distinct forms, a productive (sclerotic) or an exudative (caseous, destructive). If multiple vertebrae are involved, some may illustrate one type, some the other, and in still others both forms are present. We have found an essentially productive form existing in many vertebrae; usually the predominantly exudative type has productive elements at the periphery of the caseous areas to a greater or lesser extent.

Productive Form. In all stages the bone assumes a yellow color, these yellow areas gradually extending towards the posterior aspect and the intervertebral disc. The bone is firm and maintains its morphological integrity though the entire vertebral body be involved. The intervertebral discs are intact.

Exudative Form. The appearance of the exudative type, since it is more dramatic and more easily demonstrable, constitutes the classical picture of Pott's disease. Here, as in the productive lesion, the bone assumes a yellow color. Soft areas of liquefaction of varying size develop within the yellow areas, the liquefied areas consisting of soft gelatinous material and frequently bony fragments. With progression of the liquefying process, usually with extension into the intervertebral disc, compression of the vertebra by the body weight occurs and a gibbus results. In occasional cases sequestration of bone may be produced, by a caseous process, encircling either normal bone or bone showing productive changes. In these cases, the sequestrum maintains its integrity, bathed by liquefied material.

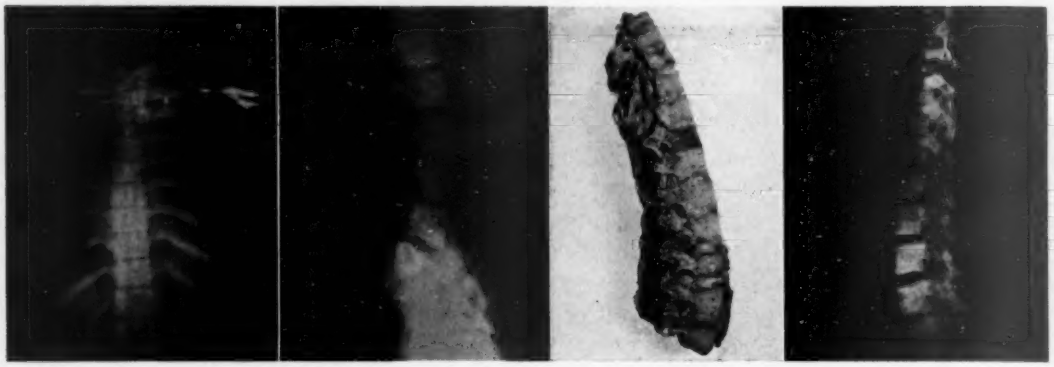


A *B* *C*

FIG. 1. Destructive Pott's disease of fifth and sixth dorsal vertebrae. *A*, antemortem anteroposterior Potter-Bucky view. *B*, postmortem lateral view, same technique, of hemisection of same spine. No additional information is added to that found before death. *C*, postmortem photograph confirms the roentgenographic diagnosis. Section taken for histological examination from seventh dorsal vertebra.

Microscopically the two types of lesions are essentially what one would expect. In the productive form, tuberculous granulation tissue, rich in capillaries, fills the marrow spaces. This granulation tissue may erode but never completely destroy the bony trabeculae. Within it, there may or may not be areas of caseation, which, however, are walled off from the trabeculae by the productive elements. The reason, therefore, why the bone, though extensively involved, is not collapsed, is obvious.

In the exudative type, the general microscopic appearance is that of large areas of caseation which have completely destroyed all normal bony architecture. In occasional



A *B* *C* *D*

FIG. 2. Productive Pott's disease of all lumbar and lower six dorsal vertebrae. *A*, antemortem anteroposterior Potter-Bucky view. Large cold abscess; lipiodol injected into chest sinuses; no bone lesion demonstrable. *B*, lateral Potter-Bucky view of lumbar spine. No bone lesion demonstrable. *C*, postmortem photograph. Productive lesions in every vertebra, most marked in the lumbar region, minimal changes in the eleventh dorsal vertebra. *D*, postmortem lateral view of hemisection, same technique as Figure 1, *C*. "Sclerotic" areas in the bone correspond to the lesion seen grossly. The bone is denser in the lower lumbar vertebrae where the most extensive involvement is found.

areas where fragments of bony trabeculae are still present, the nuclei have lost their staining properties. At the periphery of the caseation is a zone of tuberculous granulation tissue composed of dilated capillaries, epithelioid and giant cells, fibroblasts and collagen fibers. This zone of granulation tissue erodes those bony trabeculae which it borders.

ROENTGENOLOGICAL INTERPRETATION

The roentgenographic appearance of the exudative (destructive) form of Pott's disease when the vertebral body is collapsed and the disc destroyed is too well known to bear repetition here. When the caseous process is limited to the central portion of the vertebrae or its small parts, the differential diagnosis may be confusing, since pyogenic or fungus infections can produce a similar picture. However, the general clinical appearance of the patient and study of the sinuses and fistulae which sometimes occur in the tuberculous and usually in the pyogenic infections can clarify the diagnosis. In any event, the roentgenologist can detect the destructive process even if he may not, from the roentgenogram alone, predict the etiology of the condition.

When, on the other hand, the disease in the spine is an essentially productive one, it has been our experience that the possibility of its being diagnosed by the roentgenologist is remote indeed. Ninety-six of our 132 cases had had complete roentgenograms made of the spine within six months of death, usually within three months. These roentgenograms consisted of anteroposterior and lateral roentgenograms of the entire verbetral column from cervical to sacral regions. At necropsy in this group of 96, a total of 118 vertebrae or groups of vertebrae were found to have tuberculous lesions.

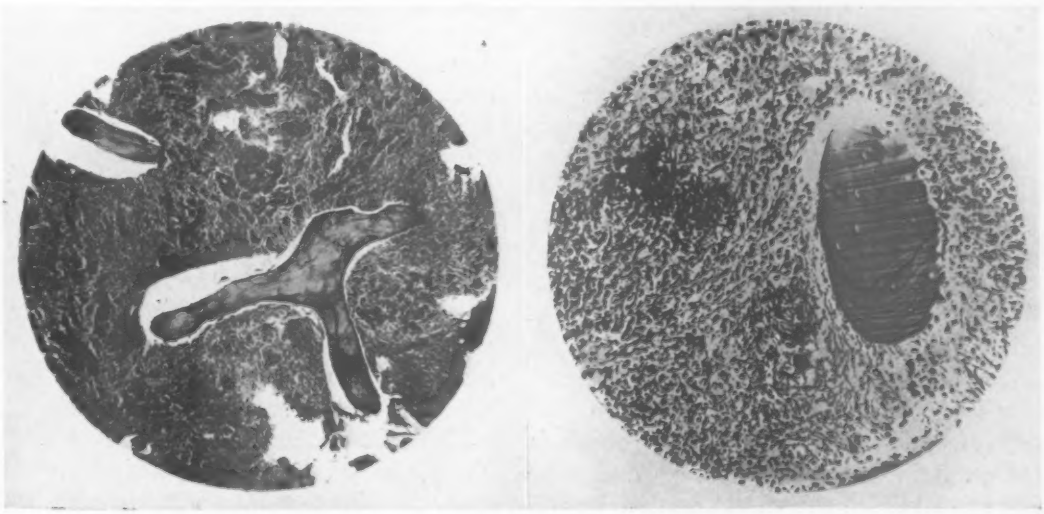
Seventy-five (63 per cent) of these were diagnosed correctly by the roentgenologist. In all of these cases the tuberculous process was a destructive one. In only 13 (11 per cent) instances did the roentgenograms fail to reveal destructive lesions. In 10 of them the roentgenograms were made more than three months before death and it is possible that at that time the process was either absent or too small to be roentgenographically demonstrable.

In contrast to this roentgenological accuracy, it is noted that not a single correct diagnosis was made in 30 (25 per cent) cases where the lesion was a productive one. In half of these, the roentgenographic

studies had been made within two months of death and in several cases within two weeks. One of these cases is particularly interesting (Fig. 2). The patient had an extensive "cold abscess" of the psoas muscles and paravertebral structures, which burrowed anteriorly beneath the ribs to the sternum. The abscess was diagnosed correctly ten months before death, but repeated complete spine roentgenograms, both at our own and other institutions, failed to reveal involvement of a single vertebral body. At necropsy every vertebra was diseased, some only partially, but the majority completely. Yet the intervertebral discs were intact and microscopic study of the bone revealed the trabeculae to be eroded but not destroyed, the caseation in the marrow spaces being more or less walled off by the productive elements. Obviously with the trabeculae intact there could be no collapse of the vertebrae or demonstration of areas of lessened density on the roentgenogram. This case was striking because of its extent; the other 29 cases with productive changes were qualitatively similar.

In an attempt to discover roentgenographic evidence which could be utilized to diagnose these productive changes before death, roentgenograms of hemisections of spines with this type of lesion were taken. Under these roentgenologically ideal conditions, one change persists—areas of increased density, corresponding exactly to the diseased areas noted grossly. These changes have been called "sclerotic," for want of a better term, although pathologically these areas are neither "hard" nor "indurated." The bone is of the same degree of firmness as that found normally, since the trabeculae themselves are essentially normal. Apparently, however, marrow spaces filled with granulation tissue and caseous material have less radiability than normal spaces filled with adipose tissue and hematopoietic elements.

With this thought in mind we reviewed the roentgenograms taken before death of the vertebrae showing productive changes. It is true that in only 2 were productive ("sclerotic") changes suggestive, perhaps because in an attempt to read only those findings which were actually present, our interpretations were too conservative. If,



A *B*

Fig. 3. Photomicrographs of two forms of Pott's disease. *A*, section through a destructive area. The bone marrow which has become completely caseous has lost its nuclear stain. The bony trabeculae which are caseous have also lost their staining ability. *B*, section through a productive, "sclerotic," area. The tuberculous granulation tissue in the bone marrow completely surrounds intact bone. A Langhans giant cell lies within the granulation tissue.

however, postmortem roentgenograms can demonstrate definite roentgenographic changes, it should be possible, with awareness of the possibilities, to develop a technique and sufficient diagnostic acumen to detect these productive ("sclerotic") changes. It is perhaps too much to expect of the roentgenogram that, without other evidence of Pott's disease, "sclerotic" changes be considered diagnostic of the productive phase of that disease. Nevertheless, where other roentgenological evidence of vertebral tuberculosis exists the possibility of this type of lesion should be considered. Serial roentgenograms should be helpful by demonstrating changes in bone density as the productive lesion progresses.

The fact that both a predominantly productive ("sclerotic") and a predominantly exudative (destructive) disease may exist in different vertebrae in the same vertebral column should also be recognized. In 128 of our cases the type of lesion was described grossly as either one or the other and the impression confirmed by histological examination. In 80 (62 per cent) cases the disease was essentially exudative; in 15 (12 per cent) it was essentially productive, and in 33 (26 per cent) both types were found in about an equal number of vertebrae. It is important, then, for the roentgenologist, even when a destructive lesion is demonstrable, to scrutinize the entire spine carefully for evidence of additional "sclerotic" (productive) changes.

COMPLICATIONS

The complications of Pott's disease, especially those demonstrable roentgenographically, assume added significance when they furnish the only evidence that tuberculous involvement of the spine is present. This situation we have found to be not unusual when the vertebral disease is a productive one.

Cold Abscess. The "cold abscess" is so integral a part of Pott's disease that it is probably injudiciously called a complication. Roentgenologically this is important, since the abscess in spite or because of its ramifications and burrowings readily lends itself to a roentgenographic diagnosis. Ornstein and Ulmar[8] have stressed the importance of the double contoured shadow of the paravertebral abscess and the advisability of complete studies of the spine on the basis of such a shadow, even without other evidence of Pott's disease.

Nathanson and Cohen,[7] in a study of 94 cases of Pott's disease, found roentgenologic evidence of an abscess in 60 per cent of their cases, in a number of which it was the only evidence of that disease. They pointed out, however, that paravertebral swellings were also present in other conditions, such as spinal cord tumors and could not, therefore, be said to be pathognomonic of tuberculosis without corroborating evidence.

One hundred and twenty-six (96 per cent) of our 132 cases were found to have "cold abscesses" at necropsy. In 2 of the remaining 6, fusion operations had been performed and the disease showed evidence of healing. The extent of the abscess varied, being limited, particularly in the dorsal region, to the involved vertebrae. On the other hand, small bony foci may produce large abscesses, while extensive vertebral disease may result in only small ones. The swelling is usually but not always bilateral. Whether the underlying bone involvement was a productive or exudative one had no relation to the size of the resulting abscess.

If they arise from a process in the lumbar vertebrae, the abscesses follow along the lateral sides of the vertebral column and thence into the sheath of the psoas muscle to form a psoas abscess. Such an abscess may also develop in a like manner from caries of the lower dorsal vertebrae. In following the course of blood vessels, a cold abscess may perforate the skin in multiple areas forming fistulous tracts. In 14 (10 per cent) of our cases the abscess perforated into the lung or pleura.

Tuberculosis of the Ribs. Tuberculous involvement of the ribs which is usually easily demonstrable roentgenologically may also furnish a clue to the presence of vertebral

disease. In 24 (18 per cent) of our cases of Pott's disease, one or more ribs were also involved. In some instances the discovery of the disease process in the rib focused attention on the vertebral column with ultimate discovery of a pathologic condition in the spine which had not previously been suspected. Admittedly the ribs may be involved without concomitant vertebral disease. This occurred in 11 (30 per cent) of 37 cases of tuberculosis of the ribs.

CONCLUSIONS

The pathology of two types of tuberculosis of the spine, exudative and productive, has been described and the roentgenological appearance of each noted. The importance of the productive form has been stressed, since such involvement even though extensive, may be impossible to detect roentgenographically. Increased density ("sclerosis") of the vertebral bodies in these cases has been suggested as of possible diagnostic significance, requiring further study. The importance of serial roentgenograms and an evaluation of the complications of Pott's disease have been described as of additional diagnostic aid.

REFERENCES

1. Auerbach, O. Tuberculosis of skeletal system. *Quart. Bull., Sea View Hosp.*, 1941, *6*, 117–147.
2. Billroth, T., and Menzel, A. Ueber die Häufigkeit der Caries in den verschiedenen Knochen. *Arch. f. klin. Chir.*, 1871, *12*, 341–370.
3. Brenner, F. Ueber klinisch latente Wirbeltuberkulose. *Frankfurt. Ztschr. f. Path.*, 1907, *1*, 293–331.
4. Cleveland, M., and Bosworth, D. M. Pathology of tuberculosis of the spine. *J. Bone & Joint Surg.*, 1942, *24*, 527–546.
5. Drachmann, A. G. Om spondylitis. *Nord. med. Ark.*, 1875, *7*, 12–18.
6. Mohr. Zur Statistik der Spondylitis. *Inaug.-Dissert.*, Würzburg, 1886. Quoted by Wullstein.[10]
7. Nathanson, L., and Cohen, W. Statistical and roentgenological analysis of 200 cases of bone and joint tuberculosis. *Quart. Bull., Sea View Hosp.*, 1941, *6*, 148–175; also, *Radiology*, 1941, *36*, 550–567.
8. Ornstein, G. G., and Ulmar, D. Tuberculous caries of vertebral bodies. *Quart. Bull., Sea View Hosp.*, 1935, *1*, 3–33.
9. Vulpius, O. Zur Statistik der Spondylitis. *Arch. f. klin. Chir.*, 1899, *58*, 268–288.
10. Wullstein, L. Spondylitis und Spondylarthritis tuberculosa. Handbuch der orthopädischen Chirurgie, G. Fischer, Jena, 1905–1907, *1*, 1225–1534.

"RING" SEQUESTRA AS A COMPLICATION OF FIXED SKELETAL TRACTION*

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THE introduction of skeletal traction revolutionized the treatment of fractures and since that time it has been very widely popularized. Its value in maintaining the position of fractures is well known but there are definite dangers associated with its use. Mathewson[6] gives an excellent discussion on the complications occurring with the use of skeletal traction. Haas[2] describes 3 instances of osteomyelitis in cases in which skeletal traction was employed. Killian,[4] Sarroste,[7] Lauber, Klapp and Siuts,[5] and Biebl,[1] also discuss osteomyelitis occurring in cases with skeletal traction.

A complication which occurs not uncommonly is the formation of "ring" sequestra, a condition frequently overlooked by the roentgenologist. I have been able to find very little reference to such a result in the literature. We have found 7 cases in our Orthopedic Clinic in the past two years. All the patients complained of pain about the Steinman pin through the upper tibia and all developed draining sinuses following the removal of the pins. Six of the patients were treated with pins incorporated in plaster casts which extended from the toes to above the knees with about 15 degrees flexion at the knees. They then became ambulatory and were seen in the out-patient clinic. Five of these 6 cases had pins inserted through the upper tibial fragment and the calcaneus. One case had a pin driven through the distal fragment as well as the proximal fragment. These 6 cases all had delayed union. The seventh patient was treated with the Kirschner wire extension. He had a fracture of the femur and humerus as well as the tibia and fibula. Non-union developed in both the femur and tibia necessitating bone grafts. A detailed description of each of the 7 cases follows.

REPORT OF CASES

CASE I. N. S., Negro, male, aged forty-two, was admitted for treatment of a compound fracture of the right tibia and fibula. Steinman pins were inserted through the upper third of the tibia and through the calcaneus on August 6, 1940. These were incorporated in a cast. The pins were removed on September 17, 1940, at which time slight drainage from the pin holes was noted and the patient complained of pain in the upper tibia. Roentgenograms taken after the removal of the cast and of the pins showed a ring of fairly dense bone immediately adjacent to the pin hole. The dense bone was surrounded by a zone of rarefaction giving the characteristic appearance of a "ring" sequestrum (Fig. 1). A sequestrectomy was done on September 28, 1940, at which time the temperature was normal and the leukocyte count was 9,950. The sequestrum was not entirely loose and had to be chiseled out. It was quite firm and had smooth outer margins. The discharge from the wound was profuse and continued to drain until March 6, 1941, at which time the sinus tract was completely healed. On March 20, 1941, the patient was walking with a cane and roentgenograms showed considerable callus formation at the fracture lines. The site of the sequestrectomy was also noted to be filling in with new bone. The patient was last seen on April 10, 1941, at which time there was good union and the patient had no symptoms.

CASE II. F. G., a white male, aged twenty-six, admitted to the hospital on March 12, 1941, with a compound fracture of the left tibia and fibula. Steinman pins were inserted through the upper third of the tibia and calcaneus. The patient complained of a great deal of pain in upper tibia and on April 10, 1941, the pins were removed. There was considerable drainage from the pin holes and roentgenograms revealed a definite "ring" sequestrum (Fig. 2). The temperature at this time was 99° F. and the leukocyte count was 11,800. A sequestrectomy was done on April 24, 1941, and a perfectly round piece of bone with the pin hole in the center was

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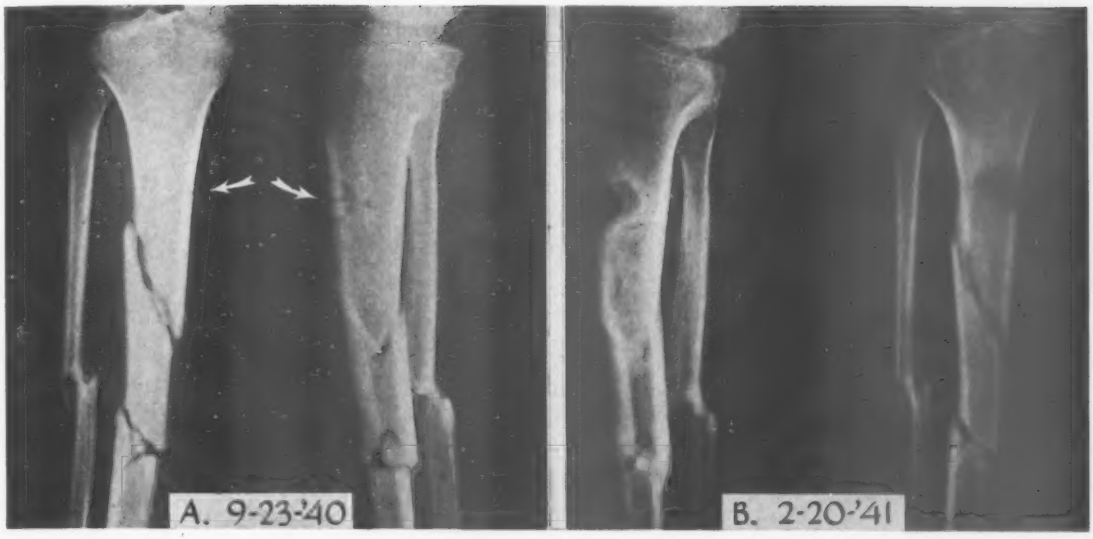

Fig. 1. Case 1. Steinman pins were put through upper fragment of tibia and calcaneus. Pins were in position for forty-two days. *A* shows the "ring" sequestrum with the density about the pin hole which is in turn surrounded by a zone of rarefaction. *B*, roentgenogram on February 20, 1941, showing some periosteal proliferation and filling in of new bone. Note also the callus formation about the fracture sites. Patient was last seen on April 10, 1941, at which time he was walking without any difficulty. Unfortunately a roentgenogram was not made at this time.

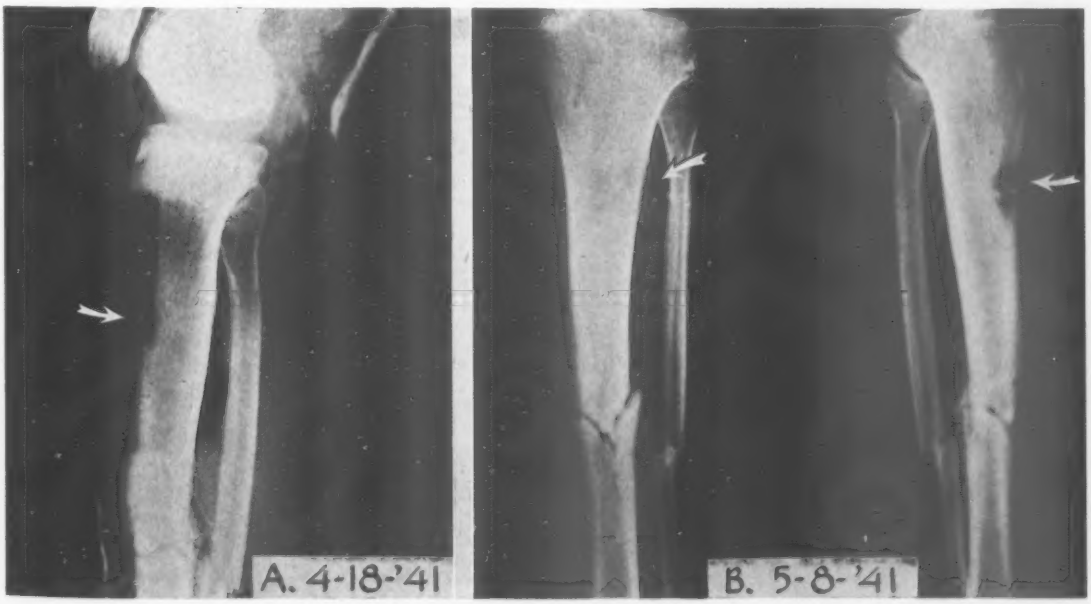

Fig. 2. Case 11. *A* shows the typical "ring" sequestrum with fairly marked resorption of bone around the sequestrum. *B* shows the appearance after removal. The sequestrum was removed through the medial aspect of tibia by following the draining sinus. Note that some pieces of the sequestrum were left in the soft tissues.

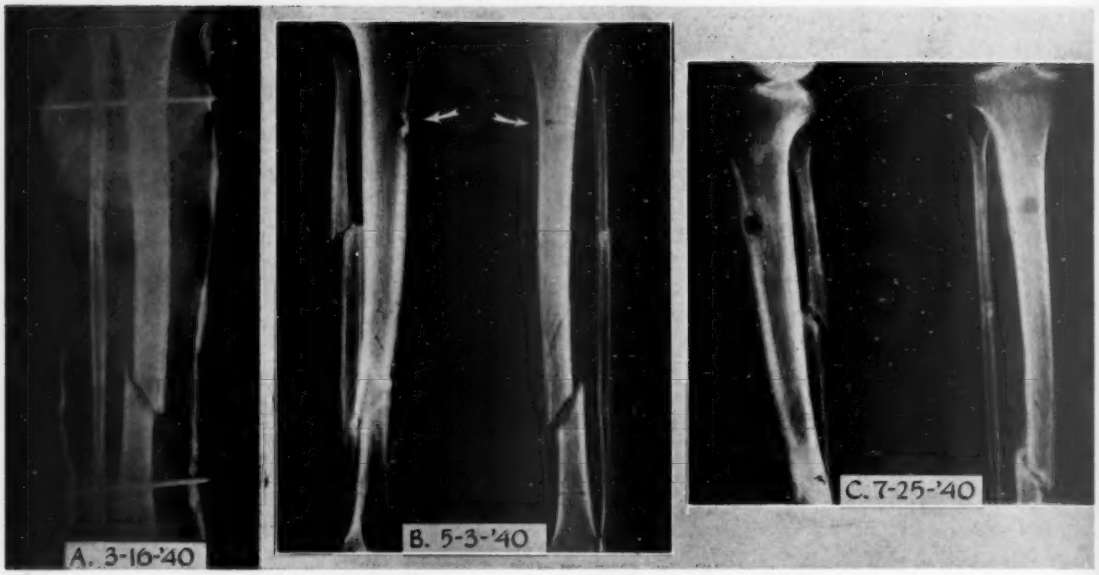

Fig. 3. Case III. *A*, pins in position. *B*, "ring" sequestrum about the upper pin hole. The normal appearing pin hole is seen in the distal fragment. Note that there is no evidence of a "ring" sequestrum in this region. *C*, after sequestrectomy.

removed. The sequestrum was lying loose in a pocket with pus about it. The bone was again noted to be firm and with a smooth outer margin. Cultures showed *Staphylococcus aureus*. Roentgenograms made on May 8, 1941, showed several loose bone fragments in the soft tissues. There was still a large amount of drainage from the sinus tract. No further follow up was obtained.

Case III. J. W., Negro, male, aged twenty-three, was admitted to the hospital with comminuted fractures of the right tibia and fibula

Fig. 4. Case V. *A*, characteristic "ring" sequestrum with rarefaction about it. *B*, appearance after removal of sequestrum. The piece of bone was lying loose in pus.

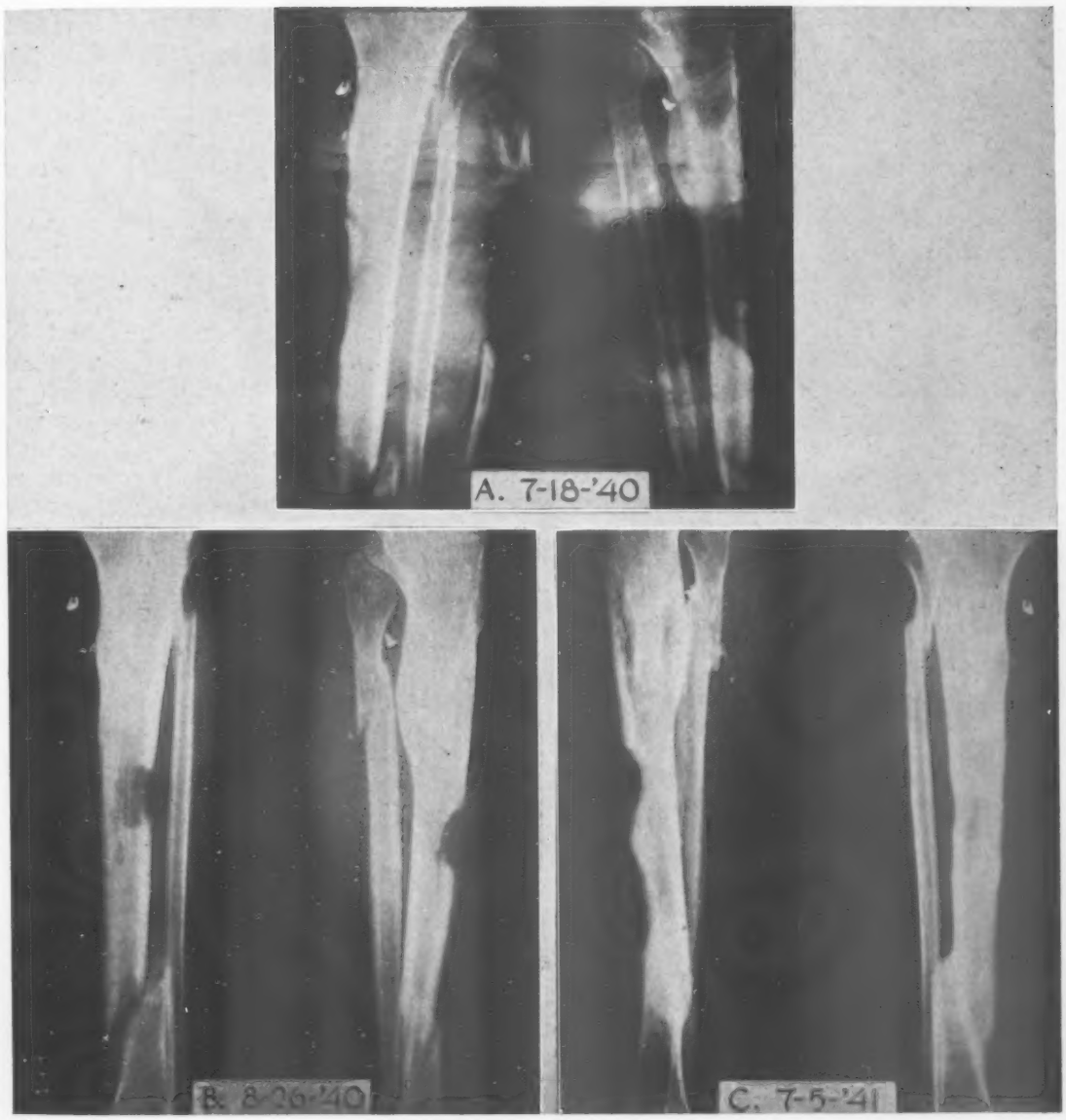

FIG. 5. Case VI. *A*, roentgenogram of leg in plaster exhibits a "ring" sequestrum. *B*, roentgenogram about one month after sequestrectomy. *C*, roentgenogram on July 5, 1941, shows that the fracture is united and that there is filling in of bone at the site of the sequestrectomy. All of the roentgenograms reveal an old osteomyelitis of the upper end of the tibia which followed a gunshot wound several years before the present admission.

on March 16, 1940, at which time Steinman pins were put through the upper and lower fragments of the tibia and incorporated in plaster. The patient was then discharged from the hospital and treated in the out-patient clinic. The pins were removed on May 3, 1940. There was some drainage from the upper pin holes associated with pain. Roentgenograms revealed a typical "ring" sequestrum (Fig. 3). A sequestrectomy was done on July 8, 1940, the procedure being carried out along the path of the draining sinus. The temperature was normal. The patient returned at frequent intervals for dressings and on August 1, 1940, only a small amount of drainage remained. Good union of the fracture was obtained.

FIG. 6. Case VII. Roentgenogram reveals a "ring" sequestrum showing the same typical appearance.

CASE IV. E. H., a white male, aged forty, was admitted with fractures of the left femur, left tibia and left humerus on November 6, 1939. Kirschner wires were put through the lower end of the femur, lower portion of the upper fragment of the tibia and through the lower fragment of the tibia. An additional wire was later put through the loose middle fragment. These wires were left in place until November 16, 1939, at which time they were removed. Roentgenograms made later showed a small ring sequestrum which is not as clearly demonstrated as those occurring with the use of Steinman pins. Non-union of the fractured femur and the tibia and fibula resulted and bone grafts were done.

CASE V. F. G., a white male, aged forty-one, was admitted on February 5, 1940, with comminuted fractures of the tibia and fibula. Steinman pins were inserted through the upper tibial fragment and the calcaneus on the following day. The case was followed in the out-patient clinic. The upper pin became loose and painful so that pins were removed eleven days after their insertion. The patient's temperature was normal but there was drainage through the pin holes. This sinus continued to drain and frequent dressings were applied. Roentgenograms on May 9, 1940, revealed a "ring" sequestrum (Fig. 4). The leukocyte count was 10,000 and there was a slight elevation of temperature on July 12, 1940, at which time a sequestrectomy was performed. Considerable pus was obtained and a circular, firm sequestrum was found lying in a cavity filled with pus.

CASE VI. J. M., a white male, aged forty, was admitted to the hospital on May 19, 1940, with an oblique fracture through the left tibia and fibula. There was also evidence of an old osteomyelitis of the upper end of the tibia as a result of a gunshot wound. There was no activity present. Steinman pins were inserted through the upper end of the tibia and the calcaneus and immobilized in a plaster cast. The patient complained of pain about the upper pin and both pins were removed on June 6, 1940. There was some purulent drainage from the pin holes. Roentgenograms made on July 18, 1940, showed the characteristic "ring" sequestrum (Fig. 5). A circular, firm sequestrum was removed on July 23, 1940, considerable pus was present and the pain was relieved. The patient returned to the clinic on several occasions at which time the wound was dressed. The sinus was healed on December 5, 1940. The patient was walking with a cane four months later.

CASE VII. C. S., a white male, aged twenty-nine, was admitted on March 6, 1941, with a fracture of the tibia and fibula of the right leg, at which time Steinman pins were inserted through the upper tibia and calcaneus and a cast applied. The patient complained of pain about the upper pin and on April 6, 1941, the pins were removed. A draining sinus developed from the pin holes. The patient was seen in the clinic on several occasions and the dressings over the sinuses were changed. Roentgenograms made on April 12, 1941, revealed a "ring" sequestrum. The patient refused an operation and came to the clinic for dressings until July 21, 1941, at which time he left town. No further follow up was available.

DISCUSSION

How do the "ring" sequestra described above come about and what is their importance? Infection is probably the chief factor as it is the greatest hazard associated with the introduction of a metal pin into bone. After the pin has been in place for a short time there is some resorption of bone immediately adjacent to it which allows movement of the pin on its long axis. Motion on the part of the patient then enables bacteria to be carried from the skin to the subcutaneous tissues and subsequently into the bone itself. Infection may thus start on

the skin and extend along the pin by direct continuity. This, we believe, is the source of the infection in the production of "ring" sequestra. One might expect the bone destruction to begin immediately adjacent to the pin but this is not the case. As shown in Figures 1, 2, 3, 4, 5 and 6 there is a hole, made by the introduction of the pin, surrounded by a zone of bone, which in turn is surrounded by an area of rarefaction. The ring of bone appears slightly more dense on the roentgenogram than does the surrounding bone. This may be explained by the fact that the surrounding bone still has its blood supply and has become atrophic from disuse, while the sequestrum has lost its blood supply and would therefore maintain its normal amount of calcium.[3]

It is instructive to note that all of our cases developed "ring" sequestra about the pin through the upper part of the tibia. At this site there is more motion of the pin and more stress is placed upon the bone. We know from the cultures that bacteria and pus are present, yet the destruction does not occur immediately adjacent to the pin which one would expect if infection were the only factor. The bone about the pin hole also appears more dense on the roentgenograms giving an appearance similar to that seen in aseptic necrosis. This evidence indicates that "ring" sequestra are probably the result of two factors—pressure necrosis and infection.

Mathewson[6] discusses the dangers of continued skeletal traction in cases which develop osteomyelitis. He gives illustrations of extensive bone destruction and migration of the pin from the bone into the adjacent soft tissues. Fortunately, the patients usually have considerable pain which calls attention to the complication. Most of our cases had no elevation of temperature and only 2 showed an increase in the white blood cell count. It is important to make the diagnosis of "ring" sequestra early in order to prevent further complications. Five of our cases were operated upon and had filling in of new bone at the site of the sequestrectomy, while their draining sinuses healed completely. Two of the cases did not have a sequestrectomy performed and still had draining sinuses at the time of the last observation. The infection is apparently of low grade so that the typical roentgenological appearance of an osteomyelitis does not develop.

SUMMARY AND CONCLUSION

1. Seven cases of "ring" sequestra developing in the upper end of the tibia following fixed skeletal traction with pins incorporated in a plaster cast are reported.

2. In six of these cases Steinman pins were used; in one a Kirschner wire.

3. Roentgenologists should give special attention to the observation of such cases as the diagnosis will depend entirely upon the roentgen examination.

4. It is important to make the diagnosis as soon as possible so that the skeletal traction may be removed.

5. Constant traction under these conditions may lead to extensive bone damage or to migration of the pin out of the bone into soft tissues, epiphyses or joints.

6. The etiology is probably pressure necrosis plus a low grade infection.

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REFERENCES

1. Biebl, M. Osteomyelitis nach Drahtextension. *Arch. f. klin. Chir.*, 1938, *192*, 1–28.
2. Haas, S. L. Late infection following use of pins and wires in bones. *J. Am. M. Ass.*, 1936, *107*, 1607–1610.
3. Jones, R. W., and Roberts, R. E. Calcification, decalcification, and ossification. *Brit. J. Surg.*, 1933–1934, *21*, 461–499.
4. Killian, H. Erfahrungen mit der Extensionsbehandlung von Knochenbrüchen. *Arch. f. klin. Chir.*, 1935, *182*, 159–198.
5. Lauber, H. J., Klapp, B., and Siuts, U. Die Drahtextension in der Behandlung der Frakturen, Luxationen und Kontrakturen mit besonderer Berücksichtigung der Komplikationen. *Zntralbl. f. Chir.*, 1939, *66*, 2265–2290.
6. Mathewson, C., Jr. Misuse of skeletal traction. *Am. J. Surg.*, 1940, *47*, 408–430.
7. Sarroste. Les séquelles infectieuses éloignés des fractures de guerre des membres (callites tardives de guerre). *Rev. de chir.*, 1935, *73*, 669–738.

OSTEOID-OSTEOMA

A REVIEW OF PORTIONS OF THE LITERATURE AND PRESENTATION OF CASES

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ALTHOUGH Jaffe's original article[1] on osteoid-osteoma appeared in 1935, it was only with the later article by Jaffe and Lichtenstein[2] in 1940, and with the presentation of the subject at that time by them and their colleagues at medical meetings, that knowledge of this interesting and important condition began to spread. Because of the likelihood that not all roentgenologists are yet familiar with osteoid-osteoma, this brief review of the paper by Jaffe and Lichtenstein and this small group of cases are presented.

Jaffe and Lichtenstein[2] reported 33 cases, more often in males, most frequently in youth, with rather wide skeletal distribution exclusive of ribs, innominate bones, and skull. History of antecedent relevant trauma was not common. Pain was the chief symptom, often mild at the onset, but becoming increasingly severe, and frequently interfering with sleep. Local swelling was a less constant complaint. Limp, stiffness, and weakness were present in some cases.

Findings on physical examination included swelling, local tenderness, limp, and sometimes atrophy. Local heat and redness, with history of fever, were notably absent.

The lesion, as they describe it, consists of a small, benign, slowly growing osteogenic tumor. In its early stages it is composed largely of osteoid tissue. Subsequently the osteoid becomes calcified and converted into hypercalcified atypical bone. They note, however, that there is no clear-cut correspondence between the age of the lesion, as represented by the patient's complaint, and the gross and microscopic observations. An outstanding characteristic of this tumor is the excessive perifocal reactive response it produces in the surrounding bone. An osteoid-osteoma arising in spongy bone is usually surrounded by a narrow zone of vascular connective tissue, which in turn is usually surrounded by a zone of sclerotic osseous tissue. Microscopic examination fails to reveal any infectious inflammatory basis for the sclerosis. When arising in cortical bone, presumably because of periosteal irritation, the deposition of sclerotic new bone is very great. When superficially located, the tumor often abuts upon, and even erodes, the overlying cortical shell. It may then elevate the periosteum, but does not penetrate the latter, and may not even stimulate it to excessive formation of bone.

With regard to the clinical diagnosis, Jaffe and Lichtenstein feel that this is really not very difficult, and that one should suspect it when the patient is an adolescent or young adult, with a well localized bone pain of at least some months' duration, with absence of fever and local heat, though some local swelling may be present. Clinical laboratory findings shed no light on the cases, but the roentgenographic appearance constitutes the most valuable single diagnostic guide. In the early stages of the tumor evolution, it appears as a roundish radiolucent or rarefied area from 5 mm. to 2 cm. in diameter. Later in its evolution, as it tends to become calcified and ossified, it may present an opacity. This opacity may, nevertheless, be made to stand out from the neighboring opaque bone by a narrow zone which is more permeable to the roentgen rays. Early

Fig. 1. Case 1. Clinically and roentgenologically a typical case of osteoid-osteoma, arising superficially against the neck of the femur, showing a partially ossified nidus, with erosion of the cortical shell, with elevation of the periosteum, without production of perifocal bone reaction. Not proved pathologically, probably because of our inexperience with osteoid-osteoma at that time.

and late in its evolution, the tumor, or nidus, is surrounded by the reactively changed surrounding tissue. This appears as a more or less opaque or dense zone. This dense area, in spongiosa, may be only a narrow ring, or it may spread for several centimeters about the lesion. In cortical bone, it may extend for several inches above and below the osteoid-osteoma proper, and for a considerable distance around the circumference of the affected shaft.

In some instances, Jaffe and Lichtenstein report, when the tumor is located in the shaft cortex of a long bone, it is difficult or impossible to trace out the opaque nidus representing the ossified osteoid-osteoma from the surrounding reactively thickened and densified cortical bone. Dr. M. M. Pomeranz, Roentgenologist of the Hospital for Joint Diseases, has shown that, under these conditions, overexposing the film and taking the roentgenogram in various planes with a cone may enable one to recognize the lesion more readily.

In differential diagnosis the authors find that these lesions are most often mistaken for bone abscess and chronic osteomyelitis. They are commonly mislabeled "chronic sclerosing non-suppurative osteomyelitis," or intracortical abscess with inflamed bone around it. The lesions have occasionally been diagnosed syphilitic osteoperiostitis, or even sclerosing osteogenic sarcoma.

It has been our privilege at the Hospital for Special Surgery to study 11 cases of osteoid-osteoma, 9 proved, and 2 which fall beyond reasonable doubt into this classification. Clinically, roentgenologically, and pathologically our cases have conformed to the descriptions and criteria of Jaffe and Lichtenstein; and perhaps our only original contribution is the recording of a case occurring in an innominate bone.

CASE REPORTS

Case 1. J. S., male, aged twenty. First seen August 23, 1939, with a history that sixteen months before, two weeks after a very minor injury, he began to have pain behind the left greater trochanter. This has persisted. He has been seen by many physicians, and has had much treatment without relief.

Examination showed tenderness over the femoral neck, limited hip motion, 3 cm. atrophy of the thigh.

A roentgenogram (Fig. 1) showed a lesion in the femoral neck, believed at that time suspicious of a small bone abscess. Roentgen ex-

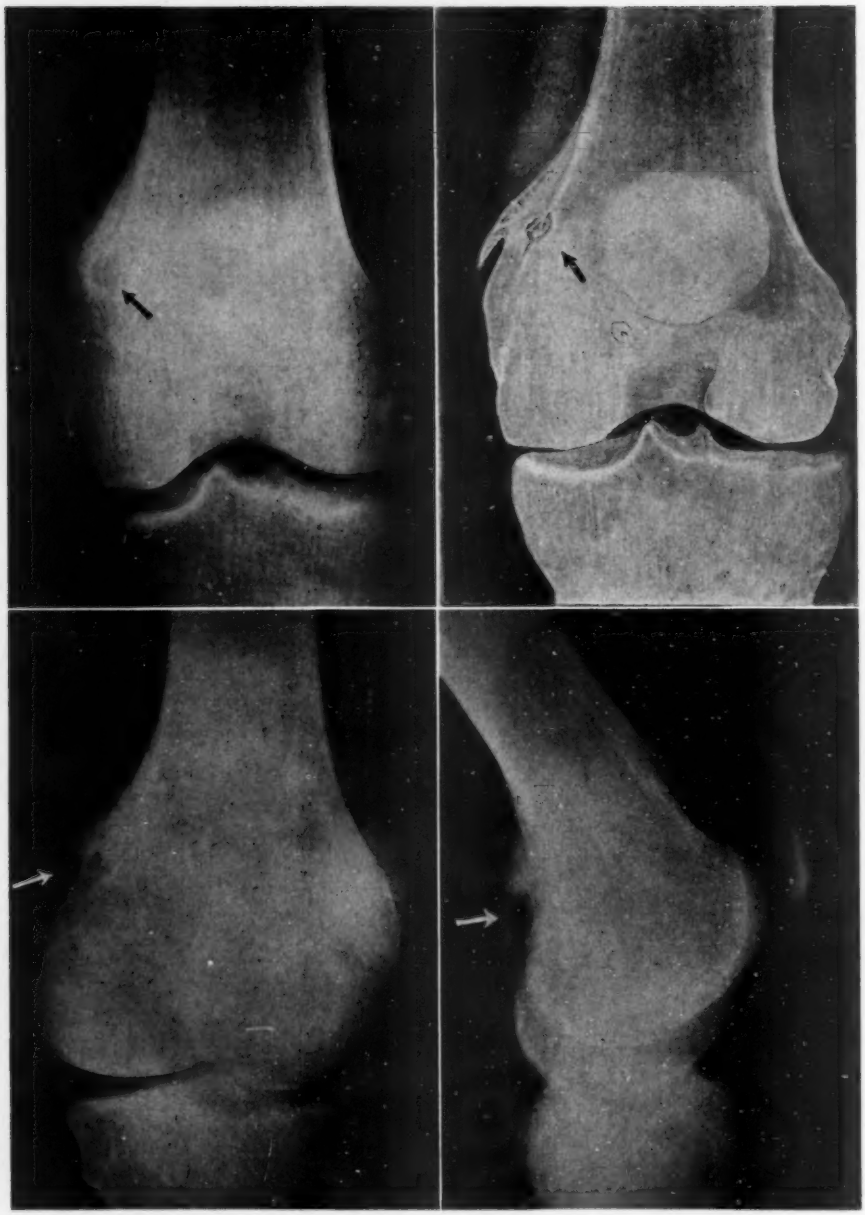

Fig. 2. Case II. Proved case of osteoid-osteoma, arising superficially near the adductor tubercle. Nidus clearly visible, and extensive perifocal bone reaction.

aminations November 16, 1939, and February 2, 1940, showed no definite change in the appearance. Dr. Ramsay Spillman, who interpreted the last roentgenograms, suggested as a diagnosis either a very low grade bone abscess or osteoid-osteoma.

An operation was performed on February 5, 1940. Roentgen examination on February 20, 1940, showed that the pathological area in the femoral neck had been widely excised.

Although the report of the pathologist was chronic inflammation, there seems little room for doubt from the clinical course and the roentgen findings that we were dealing with an osteoid-osteoma, which we did not succeed in confirming pathologically due to our inexperience with this condition at that time, this being our first case.

The patient made a good recovery and has been relieved of his pain.

Case II. C. A., male, aged twenty. The patient came to the clinic on November 19, 1940, with a complaint of pain in the knee of six months' duration. He had received diathermy from a private physician without relief.

Examination showed a tender area about the adductor tubercle, with inability to flex the knee completely.

Roentgen examination on November 28, 1940 (Fig. 2) showed a rather orderly subperiosteal deposition of lime slightly above the adductor tubercle, with a rather sharply defined rounded rarefaction just below the new lime. Osteoid-osteoma was suggested as a possible diagnosis.

The bony mass was removed at operation on November 29, 1940. Report of the pathologist: osteoid-osteoma.

Recovery and postoperative course were very satisfactory. Although a considerable mass of amorphous lime formed in the operative area, the patient has remained symptom free with a full range of motion in the knee.

Case III. M. DeC., female, aged nineteen, came to the clinic August 19, 1941, with complaint of pain and swelling at the back of the leg of twelve months' duration.

Roentgen examination of the right leg on that day (Fig. 3) showed a zone of density in the upper third of the tibial shaft, measuring about 7 cm. in length. There was subperiosteal deposition of lime on the tibia at this level, mostly posteriorly; and near the posterior cortex was a rather sharply defined zone of rarefaction. The findings suggested a bone abscess or osteoid-osteoma.

At operation on September 12, 1941, a block of bone was removed from the pathological area. Roentgen examination of the excised specimen (Fig. 3) showed that the nidus had been removed. The pathologist reported osteoid-osteoma.

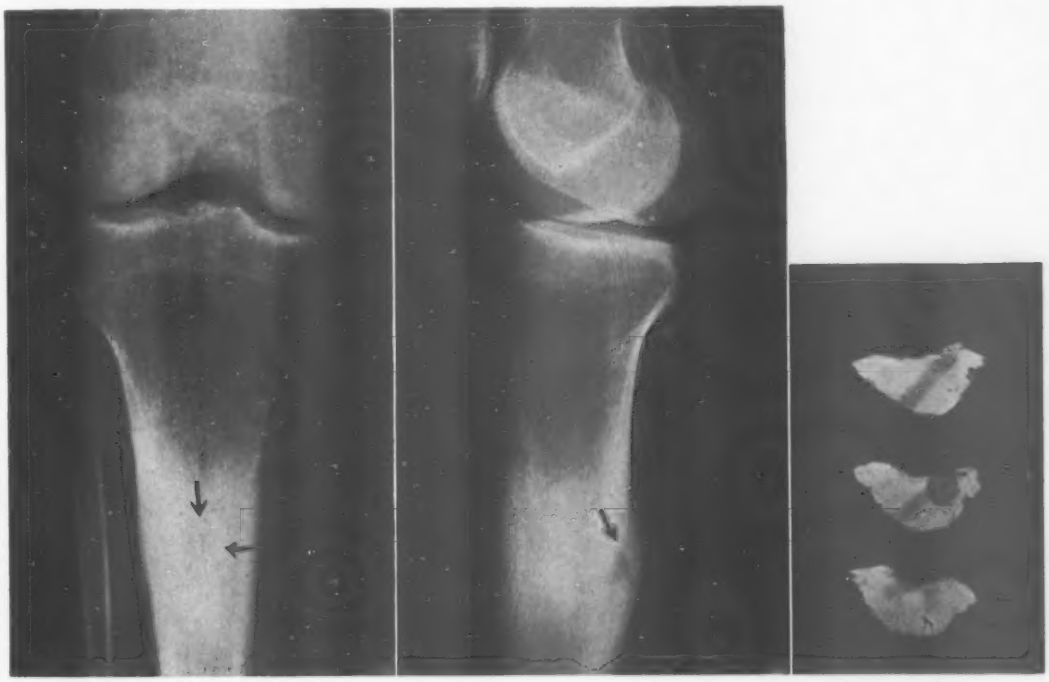

Fig. 3. Case III. Proved case of osteoid-osteoma, arising in the posterior cortex, and producing extensive perifocal reactive response in the surrounding bone. *Right*, roentgenogram of excised block of bone, demonstrating that the nidus has been removed.

The recovery was uneventful, and the patient was found symptom free at the follow-up on May 11, 1942.

Case IV. A. G., male, aged fifteen, came to the clinic September 4, 1941, with a history of having been struck by an automobile while riding a bicycle on March 16, 1941. Two months after this he began to "walk crooked" and complained of pain in the mid-back region. He cried out with pain at night, and had lost about 22 pounds in weight.

Fig. 4. Case iv. Proved case of osteoid-osteoma, arising from the right small posterior articulation between the tenth and eleventh dorsal vertebrae. Nidus and surrounding reactive sclerotic bone shown.

Examination showed a thin, undernourished boy, standing with a marked list to the left, with a left dorsal right lumbar scoliosis. Forward bending was impossible because of pain; lateral bending was restricted. There was tenderness over the lower dorsal spine, with marked muscle spasm.

Several roentgen examinations in September, 1941 (Fig. 4) revealed the list and scoliosis, and showed a moderately large deposit of lime related to the right small posterior articulation between the tenth and eleventh dorsal vertebrae.

Roentgen and clinical diagnoses were various and incorrect. A biopsy was done on an enlarged axillary node, with histopathological report of hyperplasia.

At operation on the spine October 1, 1941, a bony mass about 1 inch in diameter was found, and as much as possible was removed. The report of the pathologist was osteoid-osteoma.

The patient did not improve appreciably after the operation, and was treated at the Seaside Hospital branch for a number of months, but there was a gradual increase in the severity of the symptoms. Further roentgenograms showed that the calcareous deposit was still present, or had recurred.

A second operation was performed August 12, 1942, with removal of the bony mass. Report of the pathologist was osteoid-osteoma. Following this operation the patient made an excellent recovery, and was found symptom free and with normal mobility of the spine on June 7, 1943.

Case v. M.B., male, aged twelve and a half, was brought to the clinic October 23, 1941, because of pain in the right thigh and night cries, duration more than two years. He had been studied at another hospital without positive findings.

Examination showed right-sided limp, limited forward bending, 5° flexion contracture of the right knee, 1 cm. atrophy of the thigh, and 0.5 cm. atrophy of the calf. There was limited straight leg raising on the right.

Roentgen examination (Fig. 5) showed an area of increased density in the right ilium adjacent to the sacroiliac joint, extending forward along the brim of the true pelvis. There was a list of the lumbar spine toward the right.

By January 5, 1942, the patient was definitely worse. Roentgen examination at that time showed more scoliosis, and more tilt and rotation of the pelvis. The zone of sclerosis in the right iliac bone was present, with a small rounded area of rarefaction near the lower angle of the sacroiliac joint. The possibility of osteoid-osteoma was suggested.

At operation February 11, 1942, a block of bone was removed from the right ilium. A roentgenogram on February 14, 1942, showed that all the abnormal looking bone had been removed. Roentgenogram of the excised specimen (Fig. 5) showed that the nidus had been removed. The report of the pathologist was osteoid-osteoma.

Convalescence was uneventful with the patient free from pain. The follow-up note on June 21, 1943, reported: He walks without a limp, has no list. Has no complaints. There are no abnormal findings. Has been engaging in normal activities.

Case vi. B.G., male, aged fourteen and a half, came to the clinic February 14, 1942, with

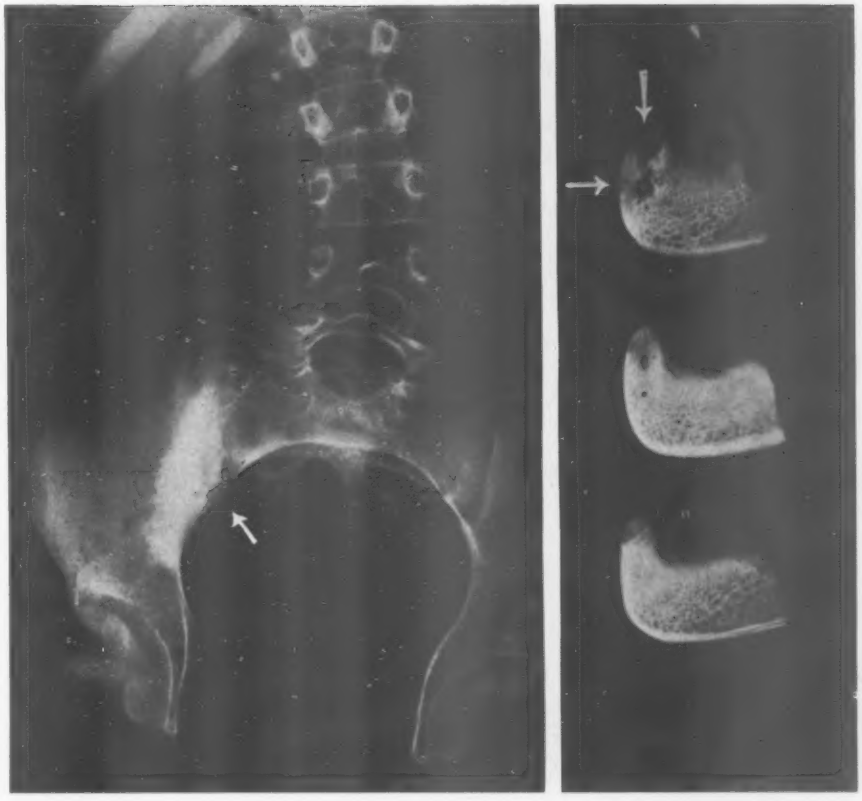

Fig. 5. Case v. Dumb-bell shaped lesion in the right ilium, with partially ossified nidus, with extensive sclerotic reaction in the surrounding bone. *Right*, roentgenogram of excised bone, showing the nidus. Proved case of osteoid-osteoma.

Fig. 6. Case vi. Partially ossified osteoid-osteoma, lying in an eroded depression in the anterior cortex, and producing marked reaction in the adjacent portions of bones. Proved case.

complaint of swelling of the left index finger. He had injured this finger while playing baseball six months before. He had been seen at another hospital where amputation was advised.

Examination showed a fusiform swelling of the finger.

Roentgen examination February 14, 1942 (Fig. 6) showed an old deformity at the junction of the shaft and head of the proximal phalanx, suggestive of an old oblique fracture without gross displacement. There was noted a curious smooth indentation on the anterior surface of the head of this phalanx, suggestive of pressure atrophy. This indentation contained a smoothly rounded bony body. A very large deposition of new bone all about the shaft of this proximal phalanx was noted, and much thickening of the surrounding soft tissues. There was no definite evidence of joint involvement. There was some roughening and thickening of the cortex of the middle phalanx. The diagnosis was uncertain, but dactylitis of some type, or osteoid-osteoma, was mentioned as a possibility.

Fig. 7. Case VII. Perifocal reactive response in tibia. The nidus could not be demonstrated even in detail roentgenograms of considerable density. Diagnosed preoperatively as osteoid-osteoma; diagnosis confirmed by pathologist.

At operation February 25, 1942, a block of bone was removed from the shaft of the proximal phalanx. This was taken proximally, and did not include the lesion near the head of the bone. Report on the excised tissue: reactive sclerosing osteitis.

A second operation was performed on March 21, 1942, and the lesion near the distal end of the phalanx was removed. Report of the pathologist: periosteal osteoid-osteoma.

The patient was seen at the end-result clinic June 28, 1943. He had no complaints, and had only 5° limitation in active and passive extension of the proximal interphalangeal joint. The residual deformity of his finger was slight.

Case VII. W.A., male, aged thirteen and a half, came to the clinic July 9, 1942, with complaint of pain along the anterolateral aspect of the right leg, just below the knee. Duration about two years, ever since he received a laceration from a spike just below the upper extremity of the fibula. The pain has been worse at night, but was sufficient to cause a limp during the daytime.

On examination, tenderness to deep pressure was elicited over the upper third of the tibial shaft.

Roentgen examination July 16 and 23, 1942 (Fig. 7) showed an old smooth enlargement of the posterior and lateral portions of the shaft of the tibia, at about the junction of the upper and middle thirds. The area of enlargement showed a homogeneous increase in density. Detail roentgenograms of considerable density failed to show any nidus or central softening. The condition was thought to be osteoid-osteoma or small cortical abscess. At operation July 29, 1942, a large block of bone was removed. In the specimen the pathologist found a very small nidus, and histopathologically the characteristic findings of osteoid-osteoma were present.

Convalescence was uneventful. He was seen about six weeks after operation, and had no complaints at that time.

Case VIII. A.L., male, aged twenty-one, came to the clinic August 31, 1942, with complaint of pain along the anteromedial aspect of the left thigh for two or three months. The pain was worse at night, leaving him very stiff in the morning. There was no history of injury. The symptoms have been present every day, and he has not been improving.

Examination showed 1 inch atrophy of the left thigh, and no other findings.

Roentgen examination (Fig. 8) showed a local orderly deposition of subperiosteal new bone along the posteromedial aspect of the femoral shaft in its middle third, for a distance of about 8 cm. In the center of the new bone formation was a small, sharply defined, oval rarefaction.

The history and findings seemed entirely characteristic of osteoid-osteoma.

The patient did not return for operation, so the diagnosis remains unproved.

Case ix. G.DeC., female, aged three, was brought to the clinic September 23, 1942, because of painful swelling of the right leg, present since January, 1941. A previous biopsy at another hospital was said by the mother to have been reported "inflammation." There was no history of injury; there has never been drainage, the pain has been worse at night causing night cries.

In the right leg about 2 inches below the knee was found a swelling about 9 by 5 cm., with a well healed scar.

Roentgen examination on October 22, 1942 (Fig. 9) showed old anterior and medial bowing of the tibia, with overgrowth of this bone as compared with the fibula. There was old thickening of the tibial cortices in the upper and middle thirds, with a central and medial rarefaction which might be the result of the old biopsy. Moderate swelling and thickening of the overlying soft tissues was noted. The findings were thought suggestive of old osteomyelitis. Osteoid-osteoma seemed less likely, and Ewing's tumor very unlikely.

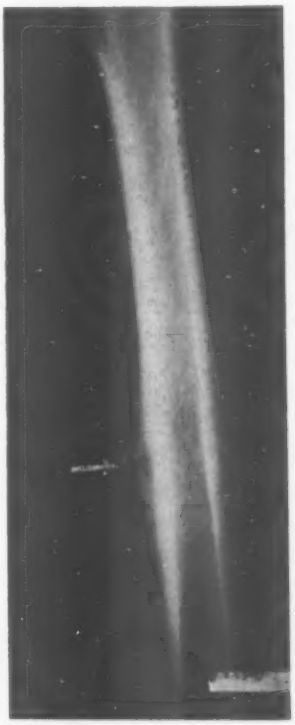

Fig. 8. Case viii. History, physical examination, and roentgenogram entirely characteristic of osteoid-osteoma. The patient did not come in for operation, so the case remains unproved.

Fig. 9. Case ix. A previous operation elsewhere was said by the mother to show "inflammation." The preoperative provisional diagnosis in our hospital, based on the clinical findings and the above roentgenogram, was chronic osteomyelitis, or possibly osteoid-osteoma. Report of pathologist: osteoid-osteoma. There was recurrence of symptoms six months after our operation, at which time the roentgenogram showed either a residual or recurrent nidus. The patient is under observation at the present time.

At operation on October 28, 1942, a flap of bone was removed, the lesion was curetted, and the wound closed.

Report of the pathologist: osteoid-osteoma.

The recovery was good, and the patient was symptom free for about six months. Since then there has been recurrence of pain and swelling, and roentgen examination showed a centrally placed, sharply defined, rounded rarefaction strongly suggestive of residual or recurrent nidus. The patient is under observation at the present time.

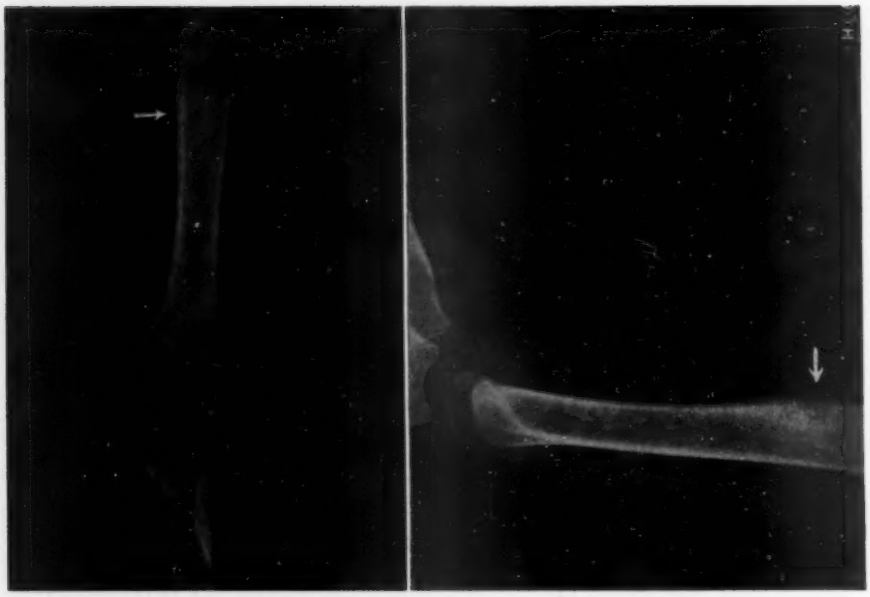

Fig. 10. Case x. Proved case. Osteoid-osteoma near the anterior cortex, with rather moderate reaction in the surrounding bone.

Fig. 11. Case xi. Typical case of osteoid-osteoma clinically, by roentgen examination and pathologically.

Case x. C.W., male, aged twenty-three months, was brought to the clinic April 5, 1943, with symptoms of weakness of the left arm. He was seen in consultation in the pediatrics clinic, and was treated with physiotherapy. Because of his failure to improve, roentgenograms were taken April 22 and 26 (Fig. 10), showing in, or close to, the anteromedial cortex of the humeral shaft in its middle third a small rounded zone of rarefaction, with parallel layers of subperiosteal lime laid down anterior to it. Osteoid-osteoma or small bone abscess was suggested as a possible diagnosis.

At operation May 12, 1943, the abnormal bone was removed. Roentgen examination of the excised specimen showed that the nidus had been included.

Report of the pathologist: osteoid-osteoma.

Recovery was uneventful. The patient was seen in the clinic June 24, 1943, at which time there were no symptoms, and there was free use of the extremity.

Case xi. C.O., female, aged sixteen, was sent into the hospital July 28, 1943, by Dr. Richmond Stephens, with a diagnosis of osteoid-osteoma. There was a ten months' history of pain in the right leg, just below the knee, gradual in onset, aching in character. No preceding injury.

Examination showed some atrophy of the thigh and leg, with no other findings.

Roentgen examination on July 28, 1943 (Fig. 11) showed, in the lateral cortex of the upper third of the right tibial shaft, a small rarefaction surrounded by a considerable zone of sclerosis, with subperiosteal new bone formation on the lateral surface of the bone. The appearance seemed entirely characteristic of osteoid-osteoma.

Operation on July 29, 1943, removed a block of bone from the pathological area. Roentgenogram of the excised specimen showed that the nidus was included. Report of the pathologist was osteoid-osteoma. The convalescence was uneventful.

SUMMARY AND CONCLUSIONS

1. Jaffe and Lichtenstein's recent article on osteoid-osteoma has been reviewed.

2. Nine proved and two probable cases of this condition are presented.

3. Clinically, roentgenologically, and pathologically our cases have conformed to the descriptions and criteria of Jaffe and Lichtenstein.

4. Simple removal of the osteoid-osteoma (the nidus) apparently brings prompt cure. Removal of all the perifocal bone reaction is probably unnecessary. Failure to remove the nidus results in persistence of symptoms.

REFERENCES

1. Jaffe, H. L. Osteoid-osteoma; benign osteoblastic tumor composed of osteoid and atypical bone. *Arch. Surg.*, 1935, *31*, 709–728.

2. Jaffe, H. L., and Lichtenstein, L. Osteoid-osteoma; further experience with this benign tumor of bone, with special reference to cases showing lesion in relation to shaft cortices and commonly misclassified as instances of sclerosing non-suppurative osteomyelitis or cortical-bone abscess. *J. Bone & Joint Surg.*, 1940, *22*, 645–682.

PANCREATIC CYST AND LITHIASIS

CLASSIFICATION AND INCIDENCE; REPORT OF A PSEUDOCYST ASSOCIATED WITH DISSEMINATED PARENCHYMAL CALCIFICATION

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MEDICAL CORPS, ARMY OF THE UNITED STATES

RECENT years have witnessed an increased interest in diseases of the pancreas resulting in new surgical, biochemical and roentgenographic techniques. The developments from the roentgenological aspect have been well summarized by Case in his splendid paper delivered as the twentieth Caldwell Lecture. The occurrence of a cyst and calculi in the pancreas of a patient stimulated a review of the etiology and incidence; interest was especially centered on any possible relation between the two lesions.

Cysts are classified as true if an inner-wall lining epithelium is present; and false, if not. This general division, however, is seldom of practical use, since in the majority of cysts this differentiation is histopathologically impossible. Anatomically, cysts are either intraparenchymal or extraparenchymal, depending upon the degree of investment by parenchyma. Again, this difference is of importance only in the operating room, since it can rarely be determined preoperatively. The following outline has been compiled from the classifications of Gross and Gulecke, Moynihan, and Mayo-Robson, Barron, and Mahorner and Mattson. To it has been added cystic fibrosis of the pancreas, a disease entity described in detail relatively recently by Andersen.

TRUE CYSTS

A. Congenital
   1. In infants
      a. Cystic fibrosis
      b. Simple or multiple cysts
   2. Dysontogenetic

B. Retention

C. Neoplastic
   1. Proliferative
      a. Cyst—adenoma
      b. Cyst—squamous epithelioma
      c. Cyst—adenocarcinoma
   2. Embryonal
      a. Dermoid or teratomatous cysts
      b. Inclusion cysts

FALSE CYSTS

A. Traumatic (pseudocysts)
   1. Hemorrhagic
   2. Apoplectic

B. Inflammatory

C. Degenerative

D. Parasitic
   1. Echinococcus (hydatid)
   2. Cysticercus cellulosae

INCIDENCE OF CYSTS

Cysts are very rare. Table 1 reveals an average incidence of 0.061 per cent from necropsy figures. Mahorner and Mattson operated on 88 patients for cysts in a total of 723,797 admissions to the Mayo Clinic, with an incidence of 0.012 per cent. For

TABLE I

INCIDENCE OF CYST FROM NECROPSY STUDIES

Authors	Necropsies	Cysts
Mayo-Robson	6,708	3
Barron	3,437	1
Guy's Hospital (Hawes)	6,000	4
McClure and Jankelson (Portis)	13,342	10
Total	29,487	18
	Per cent 0.061	

diseases of the pancreas the incidence is estimated as 1 to 2 per cent.

CLASSIFICATION OF PANCREATIC CALCULI

Stones are organic (12.7 per cent lime salts) and inorganic (93.14 per cent calcium carbonate). They are classified as true when present in a duct or ductules and the result of retention and stasis of pancreatic juice. Single stones are the exception rather than the rule. False stones consist of calcium deposition primarily in the parenchyma, usually preceded by a pathological disturbance such as acute or chronic pancreatitis. According to Beling, this distribution of calcium, frequently referred to as pancreatitis petrificans, has a definite clinical picture characterized by a history of frequent excessive indulgence in alcohol followed by repeated attacks of acute gastritis, the intervals between which are symptom free. Diabetes mellitus is absent and the pancreas shows diffuse parenchymal calcification.

INCIDENCE OF LITHIASIS

The average incidence of lithiasis from a tabulation of necropsy figures is shown in Table II. In 6,000 roentgen examinations, Morrison and Bogan found an incidence of 0.07 per cent. Snell and Comfort have called attention to the increasing number of reports in the literature during recent years. Lüdin, after a preliminary roentgenogram of the postmortem pancreas, dissected all glands showing heavy shadows; he found stones in 28 out of 542 organs for an unusual incidence of 0.51 per cent. Beling, Baker and Marquis found 1 case in 754 consecutive gastrointestinal examinations, an incidence of 0.13 per cent. This case report represents the sixteenth instance in the literature of disseminated calcification; Beling, Baker and Marquis, and King and Waghelstein have collected a total of fifteen.

RELATION OF CYST AND LITHIASIS

A rather general clinical impression, derived chiefly at operation or autopsy, exists that cysts are not infrequent sequelae of duct obstruction due to stones. This belief has not been substantiated by experimental or statistical evidence. While the literature is replete with experimental observations on the effects of obstructing the pancreatic ducts, the interest has been concentrated mainly on the external secretions. The pathological changes in the pancreas consist of atrophy of the acini and fibrosis of the parenchyma with, except in long-standing partial obstructions, preservation of the islands of Langerhans. Dilatation of ducts, ductules and acini has been described (Rich and Duff, and others), but evidence of the occurrence of cysts has been conspicuous by its absence. Archibald and Kaufman quote Lazarus as having produced a small retention cyst after simultaneously ligating the main duct and injecting tincture of iodine in the substance of the gland. This work, as far as can be determined, has not been confirmed.

Clinical observations suggesting the possibility of calculi as the cause of cysts are too numerous to enumerate. However, the presence of a stone in a duct does not necessarily implicate it as the etiological factor; intracystic calculi have also been described. Again, many cysts have been found for

TABLE II

INCIDENCE OF LITHIASIS FROM NECROPSY STUDIES

Author	Necropsies	Calculi
Mayo-Robson	6,708	3
Möckel	23,314	6
Simmonds	36,000	15
Barron	3,437	3
Zeckwer	10,300	5
Mayo	10,000	9
Rockwern and Snively	7,402	3
Guy's Hospital (Snell and Comfort)	11,000	3
Archibald and Kaufman	6,070	1
Dillon	2,800	2
Total	117,031	52
	Per cent 0.044	

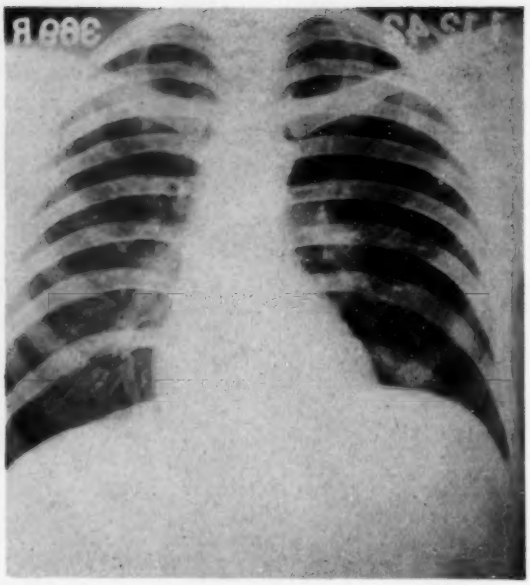

Fig. 1. The diaphragm on the left is elevated.

which no etiological explanation is available. There are other and more plausible theories of cyst formation. Better understood are the obstructions due to strictures, cancer, biliary stone at the ampulla of Vater, pressure of a duodenal diverticulum, congenital atresia and metaplasia of the duct epithelium.

The evidence seems to indicate that some initial pathologic disturbance of the pancreas is a common precursor of both cysts and calculi; the high incidence of associated biliary tract disease and atrophy and fibrosis of the gland in both conditions suggest this conclusion. In addition, the facility with which calcium is deposited in diseased tissue is well recognized; an obstructed duct with retention and stasis of the secretion, is a fertile area for precipitation of calcium salts. Acute pancreatitis may give rise to cysts or calculi. Rich and Duff have clearly demonstrated that acute hemorrhagic pancreatitis results from necrosis of vessel walls, due to trypsin liberated when the pressure in the ducts is raised as a direct consequence of obstruction. Similarly, it is not difficult to conceive of pancreatic ferments causing cystic degeneration. De Takáts and Mackenzie list cysts as a sequela of acute pancreatitis. Should areas of necrosis undergo calcification, the typical picture of disseminated pancreatic lithiasis would result. Warren has shown an incidence of 1 per cent of stones in the pancreas of patients with diabetes; this is 23 times the average incidence. Andersen studied the main duct in 12 of 45 patients with cystic fibrosis of the pancreas; in 4, dissection was impossible, in 1 case definite atresia and in 2 stenosis was present. In some of these cases she found concretions in the dilated acini. Another case in point is that described by McWhorter. His patient had a hepaticoduodenostomy for congenital dilatation of the cystic duct fourteen years before her death. Diabetes developed and she died of hypertension and nephrosclerosis. At necropsy, the pancreas was almost completely replaced by fat and fibrous tissue. The major and minor ducts showed stenosis and saccular dilatations. Multiple

Fig. 2. A flat film of the abdomen shows calcific shadows in the left upper quadrant on a level with the second lumbar vertebra.

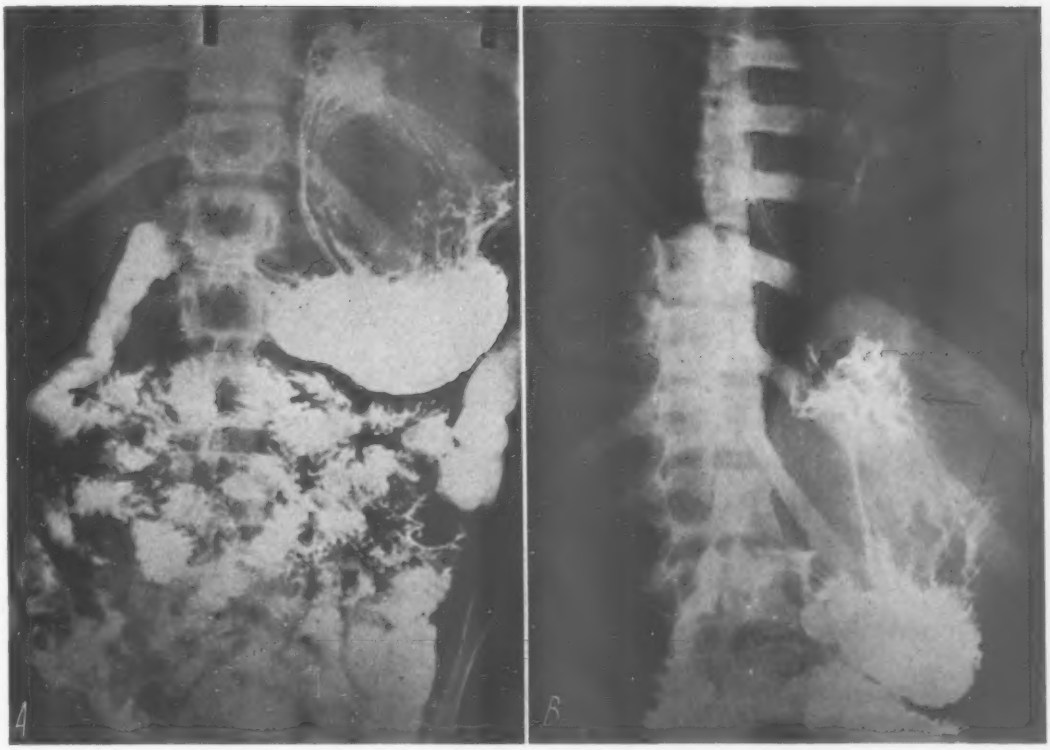

Fig. 3. *A*, posteroanterior roentgenogram showing evidence of extrinsic pressure by an oval mass. The rugae are flattened and concentrically displaced. *B*, oblique roentgenogram. Note thinning of folds of stomach and infiltration of wall of the fundus and body on the side of the greater curvature.

calculi but no cysts occurred in the dilated saccular branches of the minor duct, while retention cysts but no calculi occurred along the major duct. One retention cyst measured 3 cm. in diameter and 9 cm. in length.

CASE REPORT

H. T., male, aged twenty-eight, Army officer, was transferred from a station hospital to an Army general hospital on January 9, 1942, with a diagnosis of duodenal ulcer with severe hemorrhage. The present illness dated back two years and consisted of episodes of gastric difficulty characterized by severe pain in the abdomen and left back, nausea and vomiting, requiring opiates for relief. These episodes recurred every three to five months, lasted one to three days and were usually precipitated by indiscretions in diet or drink. The abdominal pain of the attack on December 16, 1941, radiated to the left back and base of the neck and was so excruciating that the patient slashed his wrists. The duodenal hemorrhage necessitated several blood transfusions at the station hospital.

The past history revealed the patient to be a more than moderate drinker, with occasional bouts of rather excessive alcoholic intake. In 1934 a horse rolled over the patient, injuring his left side. On another occasion he was struck in this same area by a polo mallet. In 1936 while tussling, he was rendered unconscious by a kick in the left renal area.

On physical examination, the patient was of slender physique; he appeared chronically ill with evidence of recent weight loss. There was impairment of mobility of the left diaphragm, distention of the abdomen, a palpable liver and tenderness of the lower ribs, posteriorly, on the left. The examination of the blood showed a hemoglobin of 87 per cent; red blood cells, 4,920,000; white blood cells, 10,550; polymorphonuclears, 74 per cent; lymphocytes, 25 per cent; monocytes, 1 per cent. The Kahn test and urinalysis were negative. The stool showed no occult blood or ova. The blood sugar was

FIG. 4. Combined gastrointestinal series and barium enema, again showing evidence of pressure and destruction of the wall of the stomach; the transverse colon is displaced slightly downward by the barium-filled pyloric portion. Note the normal bulb.

87.5 mg. per 100 cc. The total and free hydrochloric acid, non-protein nitrogen and phenolsulfonphthalein determinations were normal. Subsequent urinalysis showed an occasional trace of sugar; the blood sugar 140 mg. per 100 cc. The glucose tolerance curve was diabetic type. The stool was negative for fat, but positive for undigested starch.

Roentgenographic studies showed an elevated left diaphragm (Fig. 1), calcification in the pancreatic area (Fig. 2) and downward displacement of the left kidney. The proximal two-thirds of the stomach was markedly compressed by an extrinsic oval mass, such that the rugae were thinned out and concentrically displaced. While the folds were intact, the gastric wall along the greater curvature of the fundus and body was infiltrated (Fig. 3). A combined gastrointestinal series and barium enema (Fig. 4) showed a slight downward displacement of the transverse colon by the distal third of the stomach. With the patient in the Trendelenburg position, a "shelf-like" defect was noted on the posterolateral aspect of the body (Fig. 5).

On gastroscopy a large crevice with approximated edges was seen on the anterior wall just distal to the cardia; this was interpreted as a benign ulcer.

During his stay in the hospital, the patient gained weight and strength but the pain in his abdomen and back persisted, especially after meals. On March 16, 1942, the patient was operated upon. The omentum showed evidence of an inflammatory reaction. Firm adhesions were present about the inferior surface of the liver and anterior surface of the stomach. A large tumor mass about 3 inches in diameter could be felt which seemed to be in or behind the stomach at the cardiac end. The pancreas was normal in size, but hard and nodular throughout its entire length; its tail continued into the above described mass. Many adhesions were seen between the pancreas and the posterior wall of the stomach. The mass was firmly

FIG. 5. Oblique roentgenogram with patient in Trendelenburg position, showing obtuse angle formed by mass and wall of stomach.

attached to the posterior surface of the stomach; its wall was fairly thick and tense, but compressible. A needle was introduced and 200 cc. of clear straw-colored fluid was aspirated. No attempt was made to remove the cyst; a catheter for drainage was securely fixed to the interior of the cyst.

The section of the cyst wall removed was found to be composed entirely of dense, partly hyalinized fibrous connective tissue containing a moderate number of scattered polymorphonuclear cells. No cyst lining was seen. The cyst fluid had a high amylase activity; 0.003 cc. digested 0.02 gram of starch.

After a stormy postoperative course for three days the patient improved rapidly. The drainage tube was removed three weeks postoperatively. Urine, blood sugar and glucose tolerance tests were normal. Follow-up roentgenograms at seven weeks (Fig. 6) showed relief of the external pressure on the stomach. At fifteen weeks the stomach appeared almost normal; peristaltic waves were frequent, deep and regular. Some evidence of infiltration of the lesser and greater curvatures remained, however (Fig. 7).

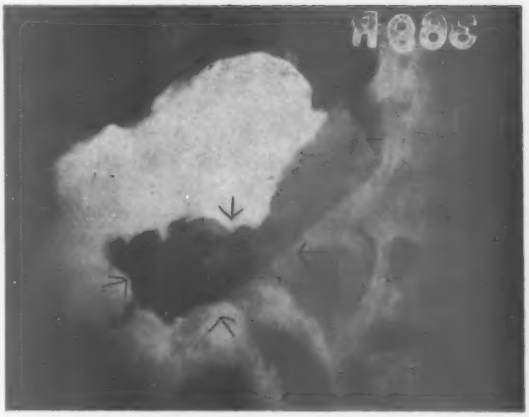

Fig. 6. Oblique projection showing result of alleviation of extrinsic pressure seven weeks after operation. Note infiltration of wall of lesser curvature.

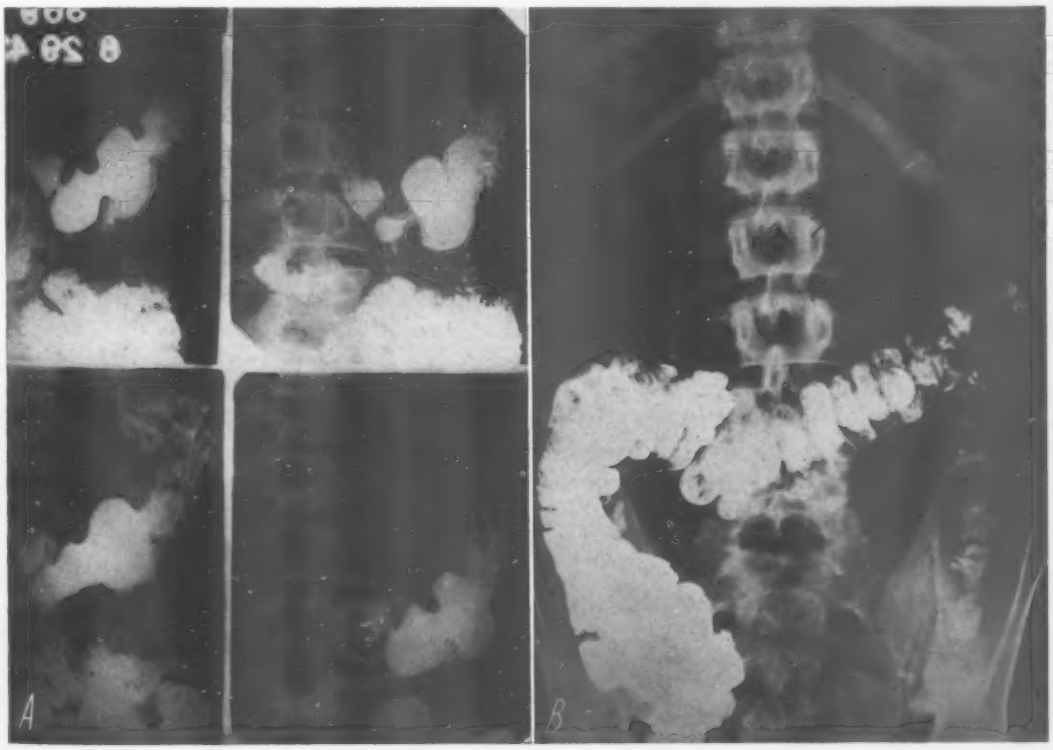

Fig. 7. *A*, serial roentgenograms showing stomach almost normal. Peristalsis is regular, the rugae are fairly normal in appearance. The lesser and greater curvatures in the region of the body and fundus, however, still show presence of a pathologic condition. *B*, six hour roentgenogram; the stomach is empty. There is better visualization of the pancreatic calcification.

COMMENT

The association of stones and cyst in this case must be considered as coincidental. There is ample evidence for the traumatic basis of the cyst; Case states that 20 per cent of cysts are due to trauma. There are sufficient findings to make a diagnosis of pancreatitis to which the lithiasis can be attributed; it is somewhat unusual in that the stones are present in the parenchyma and ducts involving the body and tail.

Rupture of a pseudocyst may be spontaneous or result from trauma. The most frequent site of perforation is in the free peritoneal cavity; it may occur in the small bowel, colon and less often the stomach. Frequently the symptoms simulate a perforated peptic ulcer and, as pointed out by Koucky, Beck and Todd, there is considerable difficulty in making a preoperative diagnosis. The seriousness of the symptoms does not permit time-consuming tests for pancreatic disease, so that the nature of the pain is significant. Pain situated to the left of the midline, or pain radiating to the left or back should raise the question of a pancreatic lesion.

The differentiation of cyst of other origin is usually not difficult. The problem arises with cancer of the stomach or pancreas. Malignant lesions generally destroy the mucosal folds. When a cyst is present, the rugae are thinned out and displaced; in this case, concentrically. The pressure defect of cancer is not smooth and clear-cut as in cyst, nor is it possible to erase it with a return to some degree of normality of the stomach.

SUMMARY

1. Pancreatic cysts and stones are classified. The classification for cysts is not new; to it cystic fibrosis has been added. Disseminated parenchymal calcification is emphasized as a definite disease entity.

2. The incidence of cyst from necropsy material is 0.061 per cent; of stone, 0.044 per cent. The latter figure is misleading since recent reports indicate a higher incidence. Because of the awareness of pancreatic disease and improved biochemical and roentgen techniques, the diagnosis of lithiasis is made more frequently than heretofore.

3. Contrary to general opinion, cysts are not sequelae of lithiasis. It is the exception rather than the rule. Evidence indicates that the same initial pathological condition, except trauma, is probably the precursor of both cyst and stone.

4. The case of pseudocyst reported presents the following interesting features:

a. Traumatic origin with spontaneous rupture into the stomach simulating bleeding peptic ulcer.

b. Association with disseminated parenchymal calcification, which of itself is extremely rare, only 16 cases, including this report, having been published in the literature to date.

c. Marked pressure on stomach with flattening, thinning out and concentric displacement of rugae.

d. Infiltration of wall of stomach in the absence of destruction of mucosal folds.

e. Return of the stomach to approximately normal appearance following operation.

5. It is emphasized that the possibility of pancreatic disease should not be overlooked when the pain is typical in location and radiation. The roentgen appearance of a smooth, well defined pressure defect of the stomach with concentric displacement of the folds strongly suggests a cyst. Associated evidence of infiltration of soft tissue is not always indicative of a malignant lesion.

REFERENCES

1. Andersen, D. H. Cystic fibrosis of pancreas and its relation to celiac disease. *Am. J. Dis. Child.*, 1938, *56*, 344–399.
2. Archibald, E. W., and Kaufman, M. Practice of Surgery. W. F. Prior Co., Inc., Hagerstown, Maryland, 1943, *7*, 44.
3. Barron, M. Diseases of the pancreas; pathologic study, with report of cases. *Arch. Int. Med.*, 1925, *35*, 807–817.
4. Beling, C. A. Calcification of the pancreas. *Am. J. Digest. Dis.*, 1940, *7*, 231–234.

5. Beling, C. A., Baker, C. F., and Marquis, W. J. Pancreatic calcification. *Radiology*, 1942, *38*, 188–190.
6. Case, J. T. Roentgenology of pancreatic disease. Am. J. Roentgenol. & Rad. Therapy, 1940, *44*, 485–518.
7. de Takáts, C., and Mackenzie, W. D. Acute pancreatic necrosis and its sequelae. *Ann. Surg.*, 1932, *96*, 418–440.
8. Gross, O., and Gulecke, N. Die Erkrankungen des Pankreas. J. Springer, Berlin, 1924.
9. Hawes, C. H. Pancreatic cyst. *New England J. Med.*, 1934, *211*, 714–716.
10. King, A. B., and Waghelstein, J. M. Calcification of the pancreas. *Arch. Int. Med.*, 1942, *69*, 165–176.
11. Koucky, J. D., Beck, W. C., and Todd, M. C. Perforation of pancreatic pseudocysts. *Surg., Gynec. & Obst.*, 1941, *73*, 113–119.
12. Lüdin, M. Die Röntgendiagnostik bei Pankreasaffektionen. *Arch. f. Verdauungskr.*, 1938, *63*, 273–291.
13. Mahorner, H. R., and Mattson, H. Etiology and pathology of cysts of the pancreas. *Arch. Surg.*, 1931, *22*, 1018–1033.
14. Mayo, J. G. Pancreatic calculi. *Proc. Staff Meet., Mayo Clin.*, 1936, *11*, 456–457.
15. McWhorter, G. L. Congenital cystic dilatation of bile and pancreatic ducts. *Arch. Surg.*, 1939, *38*, 397–411.
16. Möckel, E. Ueber Lithiasis Pancreatica mit vier eigenen Fallen. *Frankfurt. Ztschr. f. Path.*, 1921, *24*, 78–108.
17. Morrison, L. B., and Bogan, I. K. Pancreatic calculi. *New England J. Med.*, 1928, *199*, 1129–1140.
18. Moynihan, B. G. A., and Mayo-Robson, A. W. Diseases of the Pancreas and Their Surgical Treatment. W. B. Saunders Co., Philadelphia, 1903.
19. Oppenheimer, E. H. Congenital atresia of pancreatic duct with cystic fibrosis of the pancreas. *Arch. Path.*, 1940, *29*, 790–795.
20. Portis, S. A., Editor. Diseases of the Digestive System. Lea & Febiger, Philadelphia, 1941.
21. Rich, A. R., and Duff, G. L. Experimental and pathological studies on the pathogenesis of acute haemorrhagic pancreatitis. *Bull. Johns Hopkins Hosp.*, 1936, *58*, 212–259.
22. Rockwern, S. S., and Snively, D. Pancreatic lithiasis associated with pancreatic insufficiency and diabetes mellitus; report of two cases. *Arch. Int. Med.*, 1940, *65*, 873–881.
23. Simmonds, M. Ueber Lithiasis Pancreatica. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1922–1923, *30*, 81–84.
24. Snell, A. M., and Comfort, M. W. Incidence and diagnosis of pancreatic lithiasis: review of 18 cases. *Am. J. Digest. Dis.*, 1941, *8*, 237–243.
25. Warren, S. Pathology of Diabetes Mellitus. Lea & Febiger, Philadelphia, 1930.
26. Zeckwer, I. T. Hypoglycemia in diabetes associated with obstruction of pancreatic duct. *Arch. Int. Med.*, 1934, *54*, 330–338.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Twenty-eighth Annual Meeting: 1944, to be announced.

EDITORIALS

OBSERVATIONS BY A CLINICIAN ON SOME ADMINISTRATIVE PRACTICES IN HOSPITALS

RECENTLY it was my privilege to read a number of articles dealing with the many and varied phases of hospital administration. In perusing these publications, I was forcefully reminded of some thoughts that have arisen in my mind during a twenty-seven year period of close association with institutions for the care of the sick. One is that the business part of the organization is usually conducted with the greatest efficiency. With the well recognized tendency of the professional staff of most hospitals to be lacking in a real concern for the financial condition of such institutions, it is fortunate that men of the caliber with whom I have been associated are so often at the helm of this side of the hospitals' activities. Otherwise, it is undoubtedly true that bankruptcy would be facing many of them a greater proportion of the time.

Speaking from the standpoint of the clinician, however, there are at least two vital phases concerning the conduct of the hospital which are often grievously neglected. One is the regrettable lack of a genuine effort on the part of the present day hospital administrator to develop in the non-medical personnel an ever present kindly sympathetic attitude in all of their dealings with every patient, regardless of who they are and what their illness may be. The other criticism is the almost universal failure of the hospital administrative staff to understand the importance of medical research. To me, the hospitals have now developed to the point where they are efficient business organizations and for this we have the medical administrative officers to thank. Now is the time, in my opinion, when they should make a determined effort to overcome their two most obvious and remediable defects, as outlined above. In the articles which I read, an astonishingly small amount of space is devoted to these two gross deficiencies despite the fact that they were supposed to represent the best thought concerning *all that is of value for the betterment of the hospital from the administrative standpoint.*

The training of the non-medical personnel to manage patients in a satisfactory manner is a golden opportunity sadly neglected in most institutions. It has always seemed to me that several easily recognized mistakes contribute to this difficulty. One is that inefficient and poorly trained employes with relatively small salaries are placed in administrative positions which have the most important contacts with the public. Second, as these individuals are often of mediocre ability, the responsibility of altering hospital rules, under the proper circumstances, cannot be delegated to them. Consequently certain injustices are done to our patients. Third, the persons assigned to dealing with the public are not only rude in occasional instances, but more often they display an obvious urgency to hurry with their duties, which has the same unpleasant effect. To deal with either a normal or sick person hastily indicates to him or her that their problem is secondary in importance to something else. Goldwater in an article "On Humanizing the Hospital" states a real truth when he says, "a natural incongruity between personal service and a large scale organization is at the bottom of such trouble . . . . The ambition of youthful superintendents, eager to demon-

strate their executive ability, tend easily in the direction of drafting of rules; but humane administration calls for the breaking as well as the making of rules."

The necessity of certain hospital regulations is appreciated and many of the most irksome of those imposed by the administration have bothered me less when I have taken the trouble to inquire into their rationale. Nevertheless, I implore the modern hospital administrator to believe me when I reiterate to him that the success of his organization is not measured entirely in terms of dollars and cents. The public is inclined to forgive him for almost anything except an attitude of the staff which suggests a callous disregard for the sensitive emotions of a sick person and their friends and relatives. This apparent indifference of the administrative personnel seems so paradoxical because many hospital superintendents whom I have met are humane, public spirited, kindly, personable individuals, who seem to have even a special penchant for warm friendships. In other words, often their personalities are not in accord with the conduct of their institutions, in respect to the management of the public.

The other point which has not been fully appreciated by hospital executives is the important place of research in the modern institution for the care of the sick. In the past this function of the hospital has been considered as unworthy of support, or even scornfully regarded as a needless expense by some. It has been too obvious in the past, when it has been supported by the hospital, that it is the first to be lopped off the budget when funds are low. If these two statements alone are accepted, it is an indication that most superintendents consider it purely an unimportant ancillary function of the institution. Yet all concerned with the future of hospitals are reminded that the ultimate aim of such institutions, which is service to society, is likely to fall below the mark unless the medical staff is engaged in some type of medical investigative work. It need be only a simple, practical problem, but one which is calculated to improve medical practice. To fail to investigate is to fail to think in medicine. The support of research by hospital funds is almost non-existent at present, yet it is a most important aspect of practice in any institution devoted to the care of the sick. It goes further than any other single factor in guaranteeing a high grade of medical attention to the patients, which is the ultimate goal of any medical organization.

Cyrus C. Sturgis

Backrack

KARL KORNBLUM, M.D.

1893—1944

DR. KARL KORNBLUM was born in Evansville, Indiana, on March 19, 1893, and died at the University Hospital in Philadelphia on May 16, 1944, at the age of fifty-one, after an illness of only a few hours. The immediate causes of death were a cerebral thrombosis and a coronary thrombosis. Prior to this Dr. Kornblum, like his former chief Dr. Pancoast, had been ailing for several years from hypertension.

Dr. Kornblum came from the Middle West, and he inherited the characteristics of his forbears which provided him with a level head and common sense, which in him were augmented by a kindliness of nature that endeared him to his friends.

After graduating from the University of Indiana in 1916, Karl Kornblum obtained his degree in Medicine from the University of Pennsylvania in 1919. After two years of internship and one year of residency in obstetrics at the Hospital of the University of Pennsylvania, he turned his talents toward surgery, and rose to be chief of the Outpatient Department of the University Hospital during 1923 and 1924. He then went into private practice, but soon gave that up to return to the University Hospital where he became associated with Dr. Pancoast, and with whom he remained until 1933, when he became the Director of the Department of Radiology at the Graduate Hospital. In 1938 Dr. Kornblum resigned from the Graduate Hospital to accept the chair of Radiology at Jefferson Medical College, vacated by the death of Willis F. Manges. He held this chair from 1938 to 1942. He returned to the University of Pennsylvania in January, 1943, as Clinical Professor of Radiology and Associate in the Department of Radiology of the Hospital of the University of Pennsylvania, where he remained until his death.

Dr. Kornblum was one of those rare individuals who had a gift for teaching, and although he had done a considerable amount of clinical investigation and published many articles, he will be remembered long for his teaching ability. He had the rare gift of keeping the attention of his students. Because of this ability he was called upon to give a great many lectures at home and abroad, and he was constantly preparing for these lectures, the preparation of which was not a chore but a source of relaxation.

In reviewing the contributions of Karl Kornblum one finds it difficult to evaluate which will live longest, but it is universally agreed that his contributions to the study of the urinary tract during the early investigations of uroselectan and other media, and his contributions to the study of the respiratory tract will continue to be informative to those going into the specialty of radiology.

In 1925 Dr. Kornblum married Miss Mabelle Edwards, who has always been a most sympathetic and devoted wife. They have two daughters, Joan who is sixteen and Ann who is fourteen. It is my impression that their home life has been most unusual and extremely happy. Karl had no particularly hobby except that he enjoyed his family, his work, and his friends. Consequently he spent a great deal of time with his family at home and in travel, and they, like those of us who worked with him, will miss him keenly.

Karl Kornblum held the following appointments in the University of Pennsylvania prior to the time he became a Professor at Jefferson Medical College:

Instructor of Surgery, School of Medicine, 1922–1929.
Assistant Research Medicine, School of Medicine, 1923–1924.
Instructor of Radiology, Graduate School of Medicine, 1927–1934.
Instructor of Roentgenology, School of Medicine, 1929–1930.
Instructor of Radiology, School of Medicine, 1931–1933.
Assistant Professor of Radiology, Graduate School of Medicine, 1934–1938.
Director, Department of Radiology, Graduate Hospital, 1934–1938.

He was President of the Philadelphia Roentgen Ray Society 1933–1934, and was a member of many scientific societies. In all of these societies he participated in their scientific deliberations.

As a physician and a man Karl Kornblum was unusually gifted. Even though he must have had knowledge of his impending catastrophe, none of us who worked with him knew anything about it. He was a man in every sense of the word, and has fully justified the confidence which his teachers, colleagues and friends entrusted to him. As time passes, many will arise to attempt to fill his place, but it can be said without qualification that any man who can combine those rare attainments possessed by Karl Kornblum of being a brilliant teacher, an excellent clinical investigator, and a man of unquestionable integrity, should be most happy.

EUGENE P. PENDERGRASS

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Joint Meeting of American Roentgen Ray Society and Radiological Society of North America, Palmer House, Chicago, Ill., Sept. 24–29, 1944.

American College of Radiology
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

Section on Radiology, American Medical Association
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio.

Arkansas Radiological Society
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Joint Meeting of American Roentgen Ray Society and Radiological Society of North America, Palmer House, Chicago, Ill., Sept. 24–29, 1944.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Section on Radiology, California Medical Association
Secretary, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

Radiological Section, Los Angeles County Medical Association
Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

Chicago Roentgen Society
Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.

Denver Radiological Club
Secretary, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida Radiological Society
Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Michigan Association of Roentgenologists
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Hugh F. Hare, Lahey Clinic, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

North Dakota Radiological Society
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

Ohio Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. R. G. Alley, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

St. Louis Society of Radiologists
Secretary, Dr. E. W. Spinzig, 2646 Potomac, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

San Diego Roentgen Society
Secretary, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

San Francisco Radiological Society
Secretary, Dr. Martha Mottram, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Toland Hall, University of California Hospital, second six months at Lane Hall, Stanford University Hospital.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. Herman Klapproth, Sherman, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Secretary, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Continental Europe

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

FRANKLIN MEDAL AWARDED TO DR. COOLIDGE

On April 19, 1944, Dr. William D. Coolidge, vice-president in charge of research for the General Electric Company, was awarded the Franklin Medal by the Franklin Institute. The award was given Dr. Coolidge "in recognition of his scientific discoveries, which have profoundly affected the welfare of humanity, especially in the field of the manufacture of ductile tungsten and in the field of improved apparatus for the production and control of x-rays."

Science (May 5, 1944, *99*, 367) states: "Since the founding of the Franklin Gold Medal in 1914, the face of which carries a medallion of Benjamin Franklin done from the Thomas Sully portrait of Franklin owned by The Franklin Institute, it has been awarded by the institute to such figures as Thomas A. Edison, Guglielmo Marconi, Charles Fabry, Pieter Zeeman, James H. Jeans, Orville Wright, Albert Einstein and Charles F. Kettering.

"Dr. Coolidge has won many scientific awards, among them the Howard N. Potts and the Louis Edward Levy Medals of The Franklin Institute, and an honorary M.D. degree from the University of Zurich. . . .

In his acceptance of the Franklin Medal, Dr. Coolidge revealed a new development—that white-hot steel, moving at a speed of twenty miles an hour as it emerges from a rolling mill, can have its thickness accurately measured by x-rays. His work in the development of the present vacuum tube and the tube making use of the cascade principle is well known to all radiologists. The modern incandescent lamp was made possible because of Coolidge's development of the drawn tungsten filament and Langmuir's contribution of filling the lamp with gas. Tungsten, always a brittle metal because of its crystalline structure, became both ductile and fibrous as a result of Coolidge's researches and tireless effort.

DR. McNAMEE HONORED

Dr. Edgar P. McNamee of Cleveland, Ohio, a well known radiologist and a member of the American Roentgen Ray Society, was made President Elect of the Ohio State Medical Association at its Ninety-eighth Annual Meeting held in Columbus, May 2–4, 1944.

NEW YORK ROENTGEN SOCIETY

At the meeting of the New York Roentgen Society held on May 15, 1944, the following officers were elected for the ensuing year: *President*, Dr. Maurice M. Pomeranz; *Vice President*, Dr. William H. Boone; *Secretary*, Dr. Ramsay Spillman; *Treasurer*, Dr. Arthur J. Bendick; *Member of Executive Committee*, Dr. Ross Golden. Meetings are held on the third Monday of each month from November through May, at 8:30 P.M., at the Academy of Medicine.

REFRESHER COURSES

JOINT MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY AND THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Abstracts of Courses Offered

PALMER HOUSE, CHICAGO, ILLINOIS

September 24–29, 1944

A series of Refresher Courses will be presented at the time of the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, at the Palmer House, Chicago, Illinois, September 24–29, 1944.

These courses of post-graduate instruction will be given from 2 to 5 P.M. and 7 to 9 P.M., Sunday, September 24, and from 8:30 to 10 A.M. daily thereafter during the meeting. Nothing else will be scheduled during these hours, and courses have been so arranged that those interested in a particular subject may enroll in a related series.

The courses will be held on the Fourth and Club Floors of the Palmer House. Admission will be by ticket only. Reservations for enrollment will be made in the order in which they are received. Those who are not members of either of the two participating societies will be charged a fee of two dollars ($2.00) for a single course or a maximum of five dollars ($5.00) for the series. Members of the Armed Forces, Residents and Fellows in Radiology will be exempt from these charges.

Read the description of the courses, noting particularly the days upon which they are offered: study the Plan of Presentation and select carefully your choice for each day (and also indicate a second and third choice) as the number attending each course will be limited. If the directions listed in the Plan of Presentation are carefully followed, errors in enrollment will be avoided.

If the Refresher Courses are not filled by the time of the meeting, tickets will be available at the registration desk, Sunday, September 24, and thereafter.

It may be necessary to alter or revise some of the courses and to change some of the instructors; we will, however, adhere as closely as possible to your choice for the Refresher Courses.

Course No. 1: Sunday, 2–5 P.M.

Diseases of the Esophagus, Stomach and Duodenum: Panel Discussion

FAY H. SQUIRE, M.D.
Chicago, Illinois
Presiding

JAMES B. EYERLY, M.D.
JOHN M. DORSEY, M.D.
GEORGE J. RUKSTINAT, M.D.
DANELY P. SLAUGHTER, M.D.

Staff of Presbyterian Hospital, University of Illinois

(Rush) College of Medicine, Chicago, Illinois
(by invitation)

JAMES B. EYERLY, M.D.

1. Medical aspects of diseases of the esophagus, stomach and duodenum.
   a. Physiology. b. Types of diseases. c. Treatment.

FAY H. SQUIRE, M.D.

2. Radiologic examination of stomach and duodenum demonstrating pathologic changes.

GEORGE J. RUKSTINAT, M.D.

3. Pathologic anatomy of esophagus, stomach and duodenum.

JOHN M. DORSEY, M.D.

4. Surgery of the esophagus.
   a. Anatomy. b. Surgical diseases.
      (1) Congenital abnormalities. (2) Infections. (3) Tumors.

DANELY P. SLAUGHTER, M.D.

5. Surgery of stomach and duodenum.
   a. Anatomy of stomach and duodenum. b. Surgery of gastric and duodenal ulcer and carcinoma. c. Congenital obstruction of duodenum. d. Chronic duodenal ileus.

Course No. 2: Sunday, 2–5 P.M.

Roentgenologic Diagnosis of Neurological Lesions: Panel Discussion
Staff of the University of Illinois, College of Medicine
Arranged by the late ADOLPH HARTUNG, M.D.
Professor of Radiology

T. J. WACHOWSKI, M.D.
Assistant Professor of Radiology
Presiding

ERIC OLDBERG, M.D., Professor of Neurology and Neurological Surgery (by invitation)

PERCIVAL BAILEY, M.D., Professor of Neurology and Neurological Surgery (by invitation)

PAUL C. BUCY, M.D., Professor of Neurology and Neurological Surgery (by invitation)

A. S. J. PETERSEN, M.D., Associate in Radiology

Brief historical review of the roentgenologic methods used in neurological diagnosis. Technical procedures with and without contrast media. Interpretation of negatives with correlation of clinical and pathological findings. Specific information in response to requests from the audience.

Course No. 3: Sunday, 2–5 P.M.

2–3 P.M. Nuclear Physics.
K. W. STENSTROM, Ph.D., Minneapolis, Minn.

Discussion will include a simple description of the newer nuclear physics, including sub-nuclear particles such as protons, neutrons, positrons, mesotrons, etc., and the apparatus for producing them such as the cyclotron, the electrostatic generator and the betatron.

3–5 P.M. Information Please

U. V. PORTMANN, M.D., Cleveland, Ohio, Moderator

EDITH H. QUIMBY, Sc.D., New York, N. Y.

OTTO GLASSER, Ph.D., Cleveland, Ohio

JAMES L. WEATHERWAX, M.S., Philadelphia, Pa.

ROBERT S. LANDAUER, Ph.D., Highland Park, Ill.

Don't only try to "stump the experts" but send in questions on the Physics of Radiology which have been bothering you these many years. Send questions to Dr. U. V. Portmann, Cleveland Clinic, Euclid Ave. at 93rd St., Cleveland 6, Ohio.

Course 4: Sunday, 7–9 P.M.

Carcinoma of the Breast: Panel Discussion

T. LEUCUTIA, M.D.,
Harper Hospital, Detroit, Mich.
Presiding

J. J. MOORE, M.D., Pathologist, Chicago, Ill. (by invitation)

HARRY A. OBERHELMAN, M.D., Professor of Surgery, Loyola University School of Medicine, Chicago, Ill. (by invitation)

B. H. ORNDOFF, M.D., Professor of Radiology, Loyola University School of Medicine, Chicago, Ill.

JANET TOWNE, M.D., Loyola University School of Medicine (by invitation)

MAJOR JAMES C. COOK, M.C., Detroit, Mich. (by invitation)

E. WALTER HALL, M.D., Detroit, Mich.

Dr. Leucutia will briefly introduce the newer aspects on therapy, and especially the estrogenic theory, of mammary carcinoma. Dr. Moore will discuss the various pathologic aspects. Dr. Oberhelman will present the surgery of carcinoma of the breast. Dr. Towne will discuss the question of bilateral oophorectomy as a routine procedure, especially in the young, in all operable cases of mammary carcinoma and take up the problem of roentgen castration as compared to surgical castration. Major Cook will present the aspect of colloidal lead therapy in conjunction with roentgen therapy. Dr. Orndoff will discuss the radiation procedures as practiced in the various stages of mammary carcinoma. Dr. Hall will discuss the late sequelae incident to over-irradiation, the pleuropulmonary changes as well as the osseous changes.

Course No. 5: Sunday, 7–9 P.M.

Film Reading Session

MERRILL C. SOSMAN, M.D., Boston, Mass.
Presiding

ROSS GOLDEN, M.D., New York, N. Y.
EUGENE P. PENDERGRASS, M.D., Philadelphia, Pa.

Those attending the course are invited and requested to bring reports and roentgenograms of interesting or difficult cases for presentation and informal discussion. Only cases in which the diagnosis has been proved or in which the evidence is conclusive should be submitted. Those conducting the session will depend upon voluntary submission of material by members of the audience.

Course No. 6: Monday, 8:30–10 A.M.

B. R. KIRKLIN, M.D., Rochester, Minn.

Gallbladder and Pancreas

1. Cholecystography by the oral method will be described and discussed. Emphasis will be laid on the necessity of employing meticulous care in administering the dye, in executing the roentgenographic technique, and in interpreting cholecystographic response. Criteria of distinction between normal and abnormal response will be presented, and illustrative cholecystograms will be shown.
2. (a) Disclosure of tumors of the pancreas with the aid of opaque ingesta.
   (b) Roentgenographic demonstrations of pancreatic calculi.

Course No. 7: Monday, 8:30–10 A.M.

L. R. SANTE, M.D., St. Louis, Mo.

Roentgenological and Pathological Study of the Pneumonias

In recent years many causes have been found for pneumonia other than the pneumococcus. Many of these pneumonias have been described as atypical pneumonia of unknown etiology. The etiological agents for these unusual forms are so multiple and varied that they are apt to cause confusion to the roentgenologist in his understanding of the subject. To clarify the situation, a comparative study of the roentgen manifestations of the various types of pneumonia with the pathological pictures which they produce has been undertaken.

Course No. 8: Monday, 8:30–10 A.M.

EDITH H. QUIMBY, Sc.D., New York, N. Y.

Practical Problems in Dosage Measurement

This discussion will include the measurement of the quantity of x-rays in roentgens; the quality in half-value layer; the significance of air vs. backscatter measurements; percentage depth dose; exit dose; depth dose charts; isodose charts and dosage records.

Course No. 9: Monday, 8:30–10 A.M.

FRED O. COE, M.D., Washington, D. C.

Pelvimetry by Modification of Various Methods

A survey roentgenogram of the abdomen is first taken. This is followed by the conventional anteroposterior view as described by Thoms; a lateral view with the patient standing, using the dots for measurements; and a posteroanterior view of the outlet following the method of Chassard and Lapine—a total of four films. The report is a modification of that used by Snow. All methods have been modified from the original description.

Course No. 10: Monday, 8:30–10 A.M.

MAX RITVO, M.D., Boston, Mass.

Diaphragmatic Hiatus Hernia: Hernia of the Stomach through the Esophageal Hiatus of the Diaphragm

Diaphragmatic hernia of the hiatus type is a relatively common condition and must always be included among the causes of upper abdominal and chest complaints. This condition has not received from many clinicians and roentgenologists the full attention it merits. The symptomatology is indefinite and variable; hence, clinical diagnosis is usually impossible and the patient is thought to have gallbladder disease, peptic ulcer, angina, etc. Many patients with hiatus hernia have been operated upon because of these incorrect diagnoses. The roentgen ray offers an accurate and dependable method of establishing the diagnosis; it demonstrates the size of the hernia and its relationship to adjacent structures. In addition, it is important in determining the question of operability.

In this presentation, the roentgen methods of demonstrating diaphragmatic (hiatus) hernia will be described in detail. The differential diagnosis will be discussed. The signs and symptoms will be outlined and an attempt made to establish a clinical syndrome which may make a clinical diagnosis possible in many instances. The treatment of hiatus hernia will be outlined.

Lantern slide demonstration will include hiatus hernia, other types of diaphragmatic hernia, and various lesions in this region which may cause confusion in diagnosis.

Course No. 11: Tuesday, 8:30–10 A.M.

F. E. TEMPLETON, M.D., Cleveland, Ohio

Technique of Diagnosis of Duodenal Lesions by the Mucosal Relief Method

The conditions influencing the demonstration of a mucosal surface, the equipment and the technique used in examining the stomach and duodenum are discussed. The factors influencing the demonstration of mucosal surfaces are outlined as follows:

A. Physical Factors
   1. The state of the medium
   2. The condition of the mucosa
   3. The contents of the lumen
   4. The build of the patient
B. Anatomical Factors
   1. Demonstration of single surfaces
   2. Demonstration of superimposed surfaces
   3. Clinical applications
      a. Under normal conditions
      b. Under pathological conditions
C. Physiological Factors
   1. Passive factors
      a. Respiration

b. Position of the patient
c. Transmitted pulsation
d. Pressure
(1) Extrinsic
(2) Intrinsic
e. Muscular
(1) Tonus
(2) Peristalsis
2. Active factors
a. Autonomic theory of Forssell.

After briefly discussing the filming fluoroscope or "spot" machine, the technique of examination will be discussed in detail as follows:

A. Preparation of the patient
B. The media
C. Planning the examination
D. Actual roentgenologic examination
1. A routine method
a. Fluoroscopy
2. Procedures for special situations
a. Diaphragmatic hernia with a brief discussion of the phrenic ampulla
b. Cascade stomach
c. Pyloric obstruction
d. High posterior bulb, and antrum
e. Air in the duodenal bulb
f. Patients too ill to stand
g. Infants
3. Indications for exposing of the film
a. The "spot" film
b. The "survey" film
4. Application of pressure

Course No. 12: Tuesday, 8:30–10 A.M.

W. WALTER WASSON, M.D., Denver, Colo.

Diseases of the Lesser Circulation

This course will be an attempt to discuss the dynamics of the lesser circulation with a detailed presentation of the anatomy and the physiology. Every day the roentgenologist is endeavoring to evaluate in terms of pathology the air content of the lungs and the dynamics of the chest as a whole, and particularly of the lesser circulation. It is hoped that a few additional factors may be added to the present knowledge in regard to the lesser circulation. There will be a brief presentation of the clinical diseases of the lesser circulation.

Course No. 13: Tuesday, 8:30–10 A.M.

K. E. CORRIGAN, Ph.D., Detroit, Mich.

Radium Physics

This will include natural radioactive disintegration, the particles emitted by radioactive materials, half life, average life, units and the uranium disintegration series.

Course No. 14: Tuesday, 8:30–10 A.M.

WALTER C. POPP, M.D., Rochester, Minn.

Roentgen Therapy for Infectious Processes

A short introduction will be given covering the theories as well as the experimental work done by various workers, and the action of roentgen rays on infectious processes will be explained. Emphasis will be placed on the selection of technique for both acute and chronic processes. The handling of acute infections with small dosages will be considered in some detail. Statistics will be shown indicating the experience in the treatment of acute sinusitis at the Mayo Clinic. Methods of treatment of a variety of common infections will be presented as individual entities.

Courses No. 15 and 20: Tuesday and Wednesday, 8:30–10 A.M.

MERRILL C. SOSMAN, M.D.
HOWARD ARMSTRONG, M.D. (by invitation)
ORVILLE BAILEY, M.D. (by invitation)

Boston, Massachusetts
Peter Bent Brigham Hospital and the Harvard Medical School

Four Rare Diseases—Clinical, Pathological and Roentgenological Aspects: (1) Acute Disseminated Lupus; (2) Periarteritis Nodosa; (3) Erythema Nodosum; (4) Sarcoidosis

(Courses require two days for completion. Not a repeater)

These four diseases appear frequently enough in the roentgenologist's practice to warrant detailed descriptions of their clinical course, laboratory diagnosis, pathological findings and, above all, the roentgenographic aspects. One of them (acute disseminated lupus) has responded well to roentgen therapy. Complete summaries of each disease from the above mentioned aspects will be presented along with illustrative cases and methods of treatments.

Course No. 16: Wednesday 8:30–10 A.M.

ROSS GOLDEN, M.D., New York, N. Y.

Certain Aspects of Motility Disturbances in the Small Intestine

This course will include a discussion of the normal anatomy and the basic physiology involved in the three groups of intestinal movements. After dealing briefly with the normal, the disturbed motor function associated with nutritional disorders, liver disease, hypoproteinemia, ileus, and allergy will be discussed. An attempt to explain these disturbed motor phenomena in terms of basic physiology will be made.

Course No. 17: Wednesday, 8:30–10 A.M.

LESTER W. PAUL, M.D., Madison, Wis.

Diseases of the Mediastinum and Associated Conditions

In this discussion will be included those lesions which produce mass shadows of abnormal character within and adjacent to the mediastinum. The anatomy of the mediastinum and of the tracheobronchial lymph nodes will be reviewed, followed by a discussion of the roentgen anatomy of these parts. The roentgen aspects of the diseases affecting the mediastinal and tracheobronchial lymph nodes will be presented in some detail, including acute and chronic nonspecific infections, fungous infections, tuberculous adenitis in adults and primary tuberculosis. In this latter connection the lymph node changes seen in erythema nodosum will be discussed. Also reference will be made to sarcoid disease and an attempt will be made to correlate these conditions as far as present knowledge permits. The various primary and secondary tumors involving the lymph nodes will be covered, particularly Hodgkin's disease, lymphosarcoma, and metastases from primary tumors elsewhere.

Illustrative cases will be used in which serial roentgenograms show the appearance of the chest before the development of the disease, its course, and in some instances a return to normal. Emphasis will be placed on the recognition of early changes as shown by serial roentgenograms. Other diseases which may produce abnormal shadows in the mediastinum will be discussed, including lesions of the spine, pulmonary artery, aorta, esophagus, acute and chronic mediastinitis, intrathoracic thyroid, enlargement of the thymus, and certain forms of cancer of the bronchial tree. Cardiac lesions will not be included except as they must be differentiated from extracardiac abnormalities.

Course No. 18: Wednesday, 8:30–10 A.M.

OTTO GLASSER, Ph.D., Cleveland, Ohio

Electronics in Radiology

This new course, being given for the first time, will correct the impression, being foisted on the American public, about "newness" of electronics which actually is about fifty years old.

Course No. 19: Wednesday, 8:30–10 A.M.

MAJOR MILTON FRIEDMAN, M.C., A.U.S.

Biologic Reactions of Tissue to Radiation

The development of radiation therapy techniques has been predominantly based on the disappearance of the tumor and the cure rate. These indices are too remote from the immediate event to permit observations and evaluations of a specific technique. Hence the great number of "schools" of treatment.

The application of certain clinical and experimental observations of the immediate response of the tumor are helpful in reducing empiricism in radiation therapy. The mechanisms of the histological effect of radiation on tumors, the recovery processes, and the lethal tumor dose are three features discussed and correlated.

Histologic examination of biopsy specimens of a tumor under irradiation yields information of fundamental importance concerning the efficiency of treatment technique for a particular case. Radiation destroys tumor cells in several ways. Radiosensitive tumors are affected differently from radioresistant tumors. Observation of the rate and method of recession of different tumors suggests specific rates of application of radiation for each type of tumor.

Consideration of the recovery process becomes progressively more important with increased understanding of its behavior.

It is necessary to construct the plan of treatment on the basis of the daily and total tumor dose in order to intelligently apply the above principles. This procedure permits intelligent handling of a lesion, reveals the inefficiency of many commonly employed irradiation techniques, and places the treatment on a substantial basis.

Course No. 20: Wednesday, 8:30-10 A.M.

Continuation of Course No. 15.

Course No. 21: Thursday, 8:30–10 A.M.

HARRY M. WEBER, M.D., Rochester, Minn.

Lesions of the Colon Frequently and Easily Overlooked

Advanced pathologic processes occurring in the large intestine usually produce relatively marked morphologic changes in the part of the intestine affected, and so are discovered without great difficulty at roentgenologic examination. Certain clinically important lesions, however, never become large, or produce alarming symptoms even when small, or are encountered so early in their development that very obvious morphologic changes have not as yet taken place, and thus are easily overlooked at roentgenologic examination. This discussion will be limited to the roentgenologic diagnosis of small neoplastic lesions of the large intestine, and to those roentgenologically recognizable changes which signify the earliest manifestations of certain important non-neoplastic lesions of this division of the alimentary tract. The conduct of the roentgenologic examination of the large intestine will be reviewed briefly, and advantages and limitations of the various diagnostic procedures currently used in this field will be discussed in considerable detail.

Course No. 22: Thursday, 8:30–10 A.M.

C. C. BIRKELO, M.D., Detroit, Mich.

Pulmonary Tuberculosis

This presentation will consist of a lantern slide demonstration of both the common and unusual forms of pulmonary tuberculosis. The primary tuberculous infection, as it occurs in the child and young adult, will be demonstrated. Reinfection tuberculosis of both the productive and exudative types will be shown and the commonly accepted methods of treatment will be briefly discussed.

Differential diagnosis will include roentgen-ray demonstration of cases which resemble tuberculosis but have been found to be bronchopneumonia, primary and metastatic tumors of the lungs, bronchiectasis and cystic disease, lung abscess, mitral heart disease, and silicosis. All material presented will consist of proved cases.

Course No. 23: Thursday, 8:30–10 A.M.

SAMUEL BROWN, M.D., Cincinnati, Ohio

Roentgen Differentiation of Abdominal Tumors

This course will cover the roentgen diagnosis of extra-gastrointestinal tumors by an indirect method of approach which consists in the study of the stomach and intestines in their relation to the neighboring organs. It has been found that, in the presence of a tumor arising from any of the adjacent organs, characteristic changes take place in the relation, position, and contour of the hollow viscera according to the position of the body as a whole. With these facts at our disposal, it has been possible to diagnose the presence of, location, and origin of many a tumor in the abdomen.

Course No. 24: Thursday, 8:30–10 A.M.

MAURICE LENZ, M.D., New York, N.Y.

Roentgen Therapy of Hodgkin's Disease and Lymphosarcoma

Though primary regression of most clinically appreciable masses of Hodgkin's disease and lymphosarcoma is usually obtained by roentgen therapy, survival beyond three years is observed in only a small proportion of cases. In an effort to analyze the causes of these poor results, the relationship between the clinical characteristics and the technique of roentgen therapy was studied in all patients with Hodgkin's disease and lymphosarcoma treated by roentgen irradiation at the Presbyterian Hospital, New York, between 1915 and 1941. The result of this investigation will be discussed informally.

Courses No. 25 and 30: Thursday and Friday, 8:30–10 A.M.

EUGENE P. PENDERGRASS, M.D.
GEORGE W. CHAMBERLIN, M.D.
P. BOLAND HUGHES, M.D. (by invitation)
Philadelphia, Pennsylvania

Roentgenology of the Urinary Tract

(Course requires two days; the first three items will be considered on the first day and the second three on the second day)

1. Roentgen methods and materials
   a. Evaluation of types of examination
   b. Use and limitation of roentgen procedures
   c. Dangers of urography
2. The normal urinary tract
   a. Physiology
   b. Anatomy
   c. Roentgen interpretation
3. Anomalies and variants
   a. Embryology of some of the common anomalies
   b. Role of the anomalies in the development of disease
   c. Late results of anomalies
4. Roentgen interpretation of genitourinary tract disease
   a. Stones
   b. Infections
   c. Tumors
   d. Cysts
   e. Miscellaneous
5. Value of urography in disease primary outside of the urinary tract
   a. Aneurysms
   b. Retroperitoneal tumors and infections
6. Cystoscopy and urethrography

Course No. 26: Friday, 8:30–10 A.M.

LEO G. RIGLER, M.D., Minneapolis, Minn.

Roentgen Manifestations of Acute Abdominal Disorders

1. Roentgen technique in acute abdominal disorders.

Special technical procedures are necessary in the examination of patients. Variations from the usual technique in the examination of the abdomen, the difficulties, and special procedures necessary will be detailed.

2. Indications for roentgen examination in acute abdominal disorders.

The various acute processes in the abdomen in which roentgen examination is of great assistance in establishing either the diagnosis or aiding in determining the extent and nature of the process will be presented.

3. Analysis of the scout film of the abdomen.
   a. The normal appearance of the roentgenogram of the abdomen without contrast medium.

The soft tissue shadows, the appearance of the gastrointestinal tract with and without preparation and under varying conditions will be demonstrated.

   b. The abnormal roentgenogram without contrast medium.

A discussion of the physiologic and pathologic factors in the production of changes in the abdomen will be undertaken.

An analysis of the various findings which can be obtained with different types of acute abdominal disorders and their differential diagnosis will be presented.

Demonstrations will be given of the roentgen findings in : (1) peritonitis; (2) intra-abdominal abscess; (3) small intestinal obstruction; (4) large intestinal obstruction.

4. Value of roentgen examination in the acute abdominal disorders.

An estimation of the reliability of the various roentgenologic signs and their contribution toward the practical handling of the patient will be presented.

Course No. 27: Friday, 8 :30–10 A.M.

HOLLIS E. POTTER, M.D., Chicago, Ill.

Roentgen Findings in Low Back Pain

A review of both the more common and the rarer roentgen findings in low back pain which must be considered in the clinical diagnosis, the prognosis, and the treatment. Differentiation between vertebral injury and vertebral disease, congenital and acquired.

Course No. 28: Friday, 8 :30–10 A.M.

ROBERT A. ARENS, M.D.
IRVING F. STEIN, M.D. (by invitation)
Michael Reese Hospital, Chicago, Ill.

Gynecography: Pneumoperitoneum and Hysterosalpingography

The presentation will consist of a round table discussion including the history, armamentarium required, and technique for complete gynecography, including transuterine and transabdominal methods, pneumoperitoneum and hysterosalpingography alone and combined. The roentgenological procedure including the exposure, distance, posture, etc., will also be shown. Consideration will also be given to the diagnostic value of the method, its therapeutic application in tuberculous peritonitis and salpingitis and also the value of the transuterine insufflation in sterility. The teaching value of the method to students will be stressed. Lantern demonstration.

Course No. 29: Friday, 8 :30–10 A.M.

HERBERT E. SCHMITZ, M.D.

JOHN F. SHEEHAN, M.D. (by invitation)
Chicago, Ill.

Treatment of Carcinoma of the Uterus

This course will consider early diagnosis, planning of treatment, dosage, and the more common complications of carcinoma of the uterus and of the uterine cervix. Pathologic changes induced by irradiation in carcinoma of the uterus and of the uterus itself will be presented.

Course No. 30: Friday, 8:30-10 A.M.

Continuation of Course No. 25.

PLAN OF PRESENTATION

Sunday 2–5 P.M.	Monday 8:30–10 A.M.	Tuesday 8:30–10 A.M.
1. Diseases of the Esophagus, Stomach and Duodenum F. H. Squire, M.D. J. B. Eyerly, M.D. G. J. Rukstinat, M.D. J. M. Dorsey, M.D. D. P. Slaughter, M.D.	6. Gallbladder and Pancreas B. R. Kirklin, M.D.	11. Technique of Diagnosis of Duodenal Lesions by Mucosal Relief Method. F. E. Templeton, M.D.
2. Roentgenologic Diagnosis of Neurological Lesions T. J. Wachowski, M.D. Eric Oldberg, M.D. Percival Bailey, M.D. P. C. Bucy, M.D. A. S. J. Petersen, M.D.	7. Roentgenological and Pathological Study of Pneumonias L. R. Sante, M.D.	12. Diseases of the Lesser Circulation W. W. Wasson, M.D.
3. Nuclear Physics. 2–3 P.M. K. W. Stenstrom, Ph.D. Information Please 3–5 P.M. U. V. Portmann, M.D. Edith H. Quimby, Sc.D. Otto Glasser, Ph.D. J. L. Weatherwax, M.S. R. L. Landauer, Ph.D.	8. Practical Problems in Dosage Measurement Edith H. Quimby, Sc.D.	13. Radium Physics K. E. Corrigan, Ph.D.
7–9 P.M. 4. Carcinoma of the Breast T. Leucutia, M.D. J. J. Moore, M.D. H. A. Oberhelman, M.D. B. H. Orndoff, M.D. Janet Towne, M.D. Maj. J. C. Cook, M.C. E. W. Hall, M.D.	9. Pelvimetry by Modification of Various Methods Fred O. Coe, M.D.	14. Roentgen Therapy for Infectious Processes W. C. Popp, M.D.
5. Film Reading Session M. C. Sosman, M.D. Ross Golden, M.D. E. P. Pendergrass, M.D.	10. Diaphragmatic Hiatus Hernia Max Ritvo, M.D.	15 and 20. Continuous. Four Rare Diseases: Clinical, Pathological and Roentgenological Aspects M. C. Sosman, M.D. Howard Armstrong, M.D. Orville Bailey, M.D.

PLAN OF PRESENTATION

Wednesday **8:30–10 A.M.**	**Thursday** **8:30–10 A.M.**	**Friday** **8:30–10 A.M.**
16. Certain Aspects of Motility Disturbances in the Small Intestine Ross Golden, M.D.	21. Lesions of the Colon Frequently and Easily Overlooked Harry M. Weber, M.D.	26. Roentgen Manifestations of Acute Abdominal Disorders Leo G. Rigler, M.D.
17. Diseases of the Mediastinum and Associated Conditions L. W. Paul, M.D.	22. Pulmonary Tuberculosis C. C. Birkelo, M.D.	27. Roentgen Findings in Low Back Pain H. E. Potter, M.D.
18. Electronics in Radiology Otto Glasser, Ph.D.	23. Roentgen Differentiation of Abdominal Tumors Samuel Brown, M.D.	28. Gynecography: Pneumoperitoneum and Hysterosalpingography R. A. Arens, M.D. I. F. Stein, M.D.
19. Biologic Reactions of Tissue to Radiation Maj. M. Friedman, M.C.	24. Roentgen Therapy of Hodgkin's Disease and Lymphosarcoma Maurice Lenz, M.D.	29. Treatment of Carcinoma of the Uterus H. E. Schmitz, M.D. J. F. Sheehan, M.D.
20. Continuation of 15. (1) Acute Disseminated Lupus; (2) Periarteritis Nodosa; (3) Erythema Nodosum; (4) Sarcoidosis	25—(continuous) Roentgenology of the Urinary Tract E. P. Pendergrass, M.D. G. W. Chamberlin, M.D. P. Boland Hughes, M.D.	30—

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Period	First Choice		Second Choice		Third Choice	
	Course No.	Instructor	Course No.	Instructor	Course No.	Instructor
Sunday 2–5 P.M.						
Sunday 7–9 P.M.						
Monday 8:30–10 A.M.						
Tuesday 8:30–10 A.M.						
Wednesday 8:30–10 A.M.						
Thursday 8:30–10 A.M.						
Friday 8:30–10 A.M.						

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

OUTLINE OF ROENTGEN DIAGNOSIS: AN ORIENTATION IN THE BASIC PRINCIPLES OF DIAGNOSIS BY THE ROENTGEN METHOD. By Leo G. Rigler, B.S., M.B., M.D., Professor of Radiology, University of Minnesota, Minneapolis, Minnesota. Second edition. Fabricoid. Price, $6.50. Pp. 196, with 254 illustrations. Philadelphia: J. B. Lippincott Company, 1943.

This book is exactly what the title indicates. It represents a comprehensive outline of roentgen diagnosis, and is an excellent book for the student in roentgenology, or for the general practitioner who wishes to learn briefly diagnostic criteria of various diseases.

This book includes eleven sections in which the following subjects are considered:

Section One. General Principles of Roentgen Diagnosis.
Section Two. Bones and Joints.
Section Three. Diseases of the Spine and Spinal Cord.
Section Four. The Skull and its Contents.
Section Five. The Thorax.
Section Six. The Digestive Tract.
Section Seven. The Biliary Tract.
Section Eight. The Abdomen, Miscellaneous.
Section Nine. The Urinary Tract.
Section Ten. The Female Generative Organs.
Section Eleven. Miscellaneous Topics.

In addition to the text the author has included 254 well chosen illustrations and diagrams.

The author is an experienced radiologist who has a large practice. He is entirely competent to judge the type of cases with which the average practitioner is confronted.

The publishers are to be congratulated on the type of print, which is readable and not tiring to the eyes, and the illustrations, which are excellent.

EUGENE P. PENDERGRASS

THE 1943 YEAR BOOK OF RADIOLOGY. *Diagnosis:* Edited by Charles A. Waters, M.D., Associate in Roentgenology, Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital; Associate Editor, Whitmer B. Firor, M.D., Assistant in Roentgenology, Johns Hopkins University; Assistant in Roentgenology, Johns Hopkins Hospital; On leave with the Armed Forces. *Therapeutics:* Edited by Ira I. Kaplan, B.Sc., M.D., Director, Radiation Therapy Department, Bellevue Hospital, New York City; Associate Radiologist, Lenox Hill Hospital, New York City; Clinical Professor of Surgery, New York University Medical College. Cloth. Price, $5.00. Pp. 456, with 378 illustrations. Chicago: Year Book Publishers, Inc., 1943.

Despite the problems and distractions of war, there seem to be enough advances in roentgen diagnosis, enough improvements in treatment, and enough new and interesting cases to warrant the publication of numerous scientific journals. So long as articles are worth publishing in journals, so long is there need for abstracting and collecting them in convenient form for the busy man. In fact, there is now greater need than ever to conserve the time and energy of war weary doctors.

This need is met by the latest Year Book of Radiology which contains abstracts, brief reviews and comments on the most important publications of 1942 and the early months of 1943. Following the old custom of the automobile manufacturers, the Year Book appears several months before the year is over, so the present volume has been in use for a long period and has already justified the advance notices of publishers and early reviewers.

The "radiologic practice quiz" of twenty questions appearing on the cover is very intriguing, and the number might well be expanded to one hundred or more. Many specialists would no doubt fail to answer correctly all of the twenty questions, and reading of the text is bound to bring up many bits of valuable information. That there are also points of controversy is borne out by frequently interspersed editorial comments, for Waters, Kaplan and Firor do not hesitate to criticize unfavorably as well as favorably, and there are, of course, many who would not agree with either the author or the comment.

Dr. Kaplan has reviewed the entire field of

radiation therapy in an introduction of twenty-eight pages. This is alone worth the reading but it stimulates one to search the abstracts and even the original articles for further information. Waters and Firor have followed the same excellent plan of previous years in classifying diagnostic articles by body systems and tissues. The selections are well chosen for reader interest and the illustrations are numerous and well reproduced.

Space to list the contents is lacking but the student is well rewarded for the time spent with the 1943 Year Book of Radiology. Those who have past volumes will make sure that their series is unbroken.

E. Walter Hall

Fractures and Dislocations for Practitioners. By Edwin O. Geckeler, M.D., Fellow of the American College of Surgeons; Fellow of the American Academy of Orthopaedic Surgeons; Diplomate of the American Board of Orthopaedic Surgery. Third edition. Cloth. Price, $4.50. Pp. 361, with 320 illustrations. Baltimore, Maryland: Williams & Wilkins Co., 1943.

The author has achieved a condensed textbook on fractures and dislocations which well expresses the best conservative opinions of therapy today. This is a well balanced book, riding no hobbies of therapy, but stressing the fundamental principles of fracture therapy with emphasis on conservative methods of treatment.

By word and illustration, the essential details of treatment are presented with thorough simplicity. The author has properly emphasized the types of fractures which the practitioner would treat; the more complicated fractures and problems are recognized as properly referred to the more experienced bone surgeon.

An excellent bibliography is appended to each chapter for those who desire more information.

This book is an excellent text for students and an excellent review of the modern concept of treatment of fractures and dislocations for the practitioner. It is quite possible that this readable simple book will stimulate the reader to more extensive study of original articles and to texts of broader scope. Frequently, the large encyclopedic textbooks present such a colossal task to the busy practitioner that they remain unread. This text is interestingly written, authentic and of distinct educational value.

Carl E. Badgley

The Hospital in Modern Society. Edited by Arthur C. Bachmeyer, M.D., Director, University of Chicago Clinics; Director, Hospital Administration Course, University of Chicago, and Gerhard Hartman, Ph.D., Director, Newton Hospital, Newton Lower Falls, Mass. Cloth. Price, $5.00. Pp. 768. New York: The Commonwealth Fund, 1943.

This volume is an excellent compilation of carefully evaluated articles dealing with the many and varied phases of hospital administration. They have been collected for the use of the hospital director, his assistant, the department head, and board members or trustees who are desirous of a more thorough understanding of hospital procedure. The topics presented include almost every aspect of medical administration, ranging from the duties of the trustees and the financial control of an institution, to food service and housekeeping. Not the least important is a carefully selected and extensive bibliography which is appended to each section of the book. Certainly this publication should be a valuable and reliable source of information to those mentioned above, or to anyone who wishes to familiarize himself with any division of hospital administrative practice.

In reading the articles in this collection, one cannot help but be impressed with the debt which the public in general, and the clinicians in particular, owe to the hospital administrators for the modern and effective business methods which they have developed for the management of institutions for the care of the sick. With the inability of the average physician to manage his own business affairs efficiently, there might be the same application of slipshod ideas to hospital management if it were not for the now highly developed and efficient specialized principles of business management which have been developed by the hospital administrators of this country. This book is highly recommended to those who have an interest in this particular phase of hospital practice, for it can be read with profit by anyone who cares to familiarize himself with the business aspect of such organizations.

Cyrus C. Sturgis

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

SKELETAL SYSTEM

SEMMES, R. EUSTACE, and MURPHEY, FRANCIS. Syndrome of unilateral rupture of sixth cervical intervertebral disk, with compression of seventh cervical nerve root. *J. Am. M. Ass.*, April 10, 1943, *121*, 1209–1214.

From a review of the literature it would seem that most of the ruptured discs in the cervical spine produce either bilateral or unilateral cord pressure and that discs causing nerve root symptoms alone are very rare. Semmes and Murphey believe that exactly the reverse is true; that an undetermined number of patients with pain in the precordium, in the shoulder and in the arm, who heretofore were thought to have coronary thrombosis, angina pectoris, arthritis of the cervical spine, brachial plexus, neuritis and neuralgia, bursitis, scalenus anticus syndrome, cervical rib or discogenetic disease will be found to have a rupture of one of the lower cervical discs. Unilateral rupture of the sixth cervical disc with compression of the seventh cervical nerve root causes as definite a syndrome as similar lesions of the fourth and fifth lumbar discs. Four such cases are here reported, 3 of these already proved at operation.

Each patient gave a history of numerous cricks in the neck recurring intermittently for months or years preceding the attack of radiating pain. The pain radiated in each case to three general regions: (1) the precordium, (2) a point just medial to the upper angle of the scapula and (3) down the lateral and medial surfaces of the arm. In each instance there was considerable difficulty in breathing and a sense of impending death and in 1 case cyanosis. After a few days or weeks the precordial pain abated to some extent and that in the rhomboid region and arm became more pronounced. Three patients complained of definite numbness and weakness in the index finger and slight numbness in the middle finger. Roentgen examination of the cervical spine showed a straightening of the cervical curve in each instance. There was no evidence of hypertrophic arthritis in any of these cases at the beginning of symptoms. The diagnosis of this condition was made solely on the basis of the history and physical findings. No contrast medium in the spinal canal was used.

The operative procedure was carried out under local anesthesia. Subtotal hemilaminectomy was performed and the loose fragments of fibrocartilage were removed, thus relieving the pressure on the nerve. Two of the 3 patients operated on now are relieved completely of all of their original pain; whereas the third, although relieved of the shoulder pain, still has some discomfort in the arm and occasional pain in the precordium.

Hypertrophic arthritis and/or narrowing of the intervertebral disc rarely causes nerve root pressure or pain. Rupture of any intervertebral disc may result in hypertrophic changes on the edges of the adjacent vertebrae.—*S. G. Henderson.*

DUNCAN, WILLIAM, and HOEN, THOMAS I. A new approach to the diagnosis of herniation of the intervertebral disc. *Surg., Gynec. & Obst.*, Aug., 1942, *75*, 257–267.

The authors, working at the Hospital for Special Surgery maintained by the New York Society for the Relief of the Ruptured and Crippled, found that the accepted neurologic and myelographic criteria for diagnosis of the herniated disc often led to error. Therefore, they employed a new diagnostic approach which is proving satisfactory.

Three types of herniation were noted: (1) a simple herniating mass of fragmented cartilage and degenerative nuclear material distending the intact posterior capsule; (2) in the second type, the joint capsule has been ruptured and the cartilaginous sequestra have migrated into the extradural space; (3) there is fibrous fixation of the protrusion and involved nerve elements and frequently bony proliferation within the joint capsule.

Diagnosis. Special bending roentgenograms are taken in lateral flexion to both sides and in forward flexion and extension. In the majority of the authors' cases, these roentgenograms have demonstrated a lack of spinal mobility localized to the involved joint. On the involved side, the joint may fail to narrow as much as the

joints above and below or may even remain wedged open. Bending to the painful side usually demonstrates little, if any, resiliency within the affected joint. Lateral views of the spine with the patient in extreme flexion and extension may also demonstrate a mechanical obstruction in the posterior aspect of the joint which will be apparent in the view in extension. The involved disc will fail to allow extension as do the joints above and below. It is emphasized that these "bending films" serve primarily to establish the level rather than the presence of a disc protrusion.

A patient with a disc protrusion faces the problem of transmitting the body weight along the spinal column without compressing the diseased area of the disc, thus avoiding further extrusion of the cartilaginous debris along the course of the herniation. To do this, one must tilt the spine away from the involved area of the disc. This posture entails a list of the spine away from the side of the lesion, and, since the mass is extruding posteriorly, an attitude of forward flexion is assumed.—*Mary Frances Vastine.*

Smith, Alan DeForest, and Miller, Lawson E., Jr. The laminagraph as an aid in the treatment of chronic osteomyelitis. *Surg., Gynec. & Obst.*, Oct., 1942, *75*, 507–509.

One of the difficulties often encountered in the treatment of chronic osteomyelitis is the accurate localization of abscesses which give rise to recurrent attacks of pain, swelling, and fever. When a laminagraph was acquired by the New York Orthopaedic Hospital it was used in these cases. The authors conclude: (1) an increase of bone detail is available by the use of the laminagraph; (2) the laminagraph affords better localization of a bone abscess with regard to both site and level; (3) the laminagraph may help in the prevention of operation for just one abscess when more may be present; (4) the use of lipiodol in draining sinuses is suggested when roentgenographic examinations are made.—*Mary Frances Vastine.*

Blaisdell, Jack, and Harmon, Paul H. Suppurative joint disease and its relation to pyogenic osteomyelitis; a review of end-results of 67 involved joints in 57 patients; modern chemotherapeusis. *Surg., Gynec. & Obst.*, April, 1942, *74*, 796–808.

The authors found 57 patients with suppurative joints in the records of the Guthrie Clinic and these cases represent the basis for this comprehensive study of suppurative joint disease. The considerations in the article which are of roentgenological interest include:

1. The chief conditions to be considered in differential diagnosis are (*a*) acute rheumatic fever; (*b*) sympathetic sterile joint effusion produced by trauma or neighboring infection; (*c*) intermittent hydro-arthrosis; (*d*) joint tuberculosis; (*e*) hemophilia; (*f*) traumatic hemarthrosis, which may accompany marginal fractures and "sprains"; (*g*) acute rheumatoid arthritis in children, Still's disease; (*h*) acute bursitis; (*i*) peri-articular cellulitis; (*j*) small fractures and sprains.

2. When the patient with suppurative joint disease is first examined no bone or joint abnormality will be seen on the roentgenogram unless the patient has had previous neighboring bone disease. (*a*) The earliest roentgen finding is narrowing of the joint space; (*b*) demineralization of the bones due to acute suppuration may not be visualized by roentgen examination until three to four weeks after onset. (It may be seen as early as seven days following the onset of the infection); (*c*) there is progressive demineralization of the bones as visualized by roentgenograms taken at weekly or fortnightly intervals; (*d*) if the pus is not removed, solution of the cartilage promptly occurs and the joint will show erosion of the bony articular cortex or sequestration of this structure with solution of the underlying cancellous bone.

3. A certain number of pyogenic joints are confused with tuberculous joint involvement as the roentgen appearance is likely not to be characteristic of either. Aspiration with or without joint irrigation is the only means of diagnosis.

4. Frequency of joint involvement by suppuration is in the following order: hip, knee, ankle, shoulder, elbow, and wrist.

5. The necessity of early diagnosis by joint aspiration and bacterial culture and smear is shown, since upon the results from bacterial culture and smear the proper chemotherapeutic agent is selected. When this information is lacking during the first few hours, the chemical agents that are active against the hemolytic *Staphylococcus aureus* are to be used presumptively and change, if any, made as the result of the bacteriological findings. In children who have acute joint complications following upper respiratory and middle ear infections, sulfanil-

amide is to be used presumptively.—*Mary Frances Vastine.*

BORAK, J. Relationship between the clinical and roentgenological findings in bone metastases. *Surg., Gynec. & Obst.*, Nov., 1942, *75*, 599–604.

It has long been recognized that carcinomatous metastases may be present in bones without this invasion being visible roentgenologically. This is particularly true of the vertebral bodies. Tumor cells brought to the bone by the blood stream via the nutrient arteries, settle primarily in the wide spaces of the spongy portion. Thus, the compact portion of bone is affected primarily only in rare instances. The vertebrae are particularly rich in spongy bone so this is probably the reason why they are so often the site of predilection of metastases. Spongy bone forms a wide meshwork of very thin trabeculae while the compact bone forms a thick layer of dense bone tissue. Consequently, the spongy bone produces a shadow of much less density than the compact bone. It is, therefore, understandable that lesions in the vertebrae may go undetected since the latter consist exclusively of spongy bone.—*Mary Frances Vastine.*

THOMAS, ATHA. Vascular tumors of bone; a pathological and clinical study of twenty-seven cases. *Surg., Gynec. & Obst.*, April, 1942, *74*, 777–795.

This paper is the result of a study of all the vascular tumors recorded with the Registry of Bone Sarcoma of the American College of Surgeons; it also includes 2 personal cases. An attempt is made to analyze and classify further all the vascular tumors of the Registry. An analysis of current opinions on the pathogenesis and classification of vascular tumors in general is presented in an attempt to clarify the confusion that exists concerning this controversial group of tumors.

Benign Angioma.

1. This is a highly differentiated structure composed of fully developed blood vessels, which grows slowly and with little evidence of cellular activity.

2. Probably the vertebrae are the most common site for these tumors. The flat bones of the skull, pelvis, and shoulder are involved frequently, the long bones of the extremities being next in frequency.

3. In the vertebrae the tumor often produces pressure on the cord with neurological signs of varying degree. Occasionally vertebral angioma associated with epidural angioma has been reported.

4. The roentgenographic appearance in the vertebrae is characteristic. There is an irregular absorption of bony trabeculae and a thickening of the remaining vertical trabeculae with resulting parallel vertical striations and loss of the normal homogeneous structure. Not uncommonly these trabeculations extend into the vertebral arches.

Involvement of the flat bones often presents a characteristic "sunburst" appearance. Bony trabeculations radiate from a common center.

The roentgenographic appearance of angioma of long bones has been described as the unique "soap bubble" effect. There are coarsely multiloculated areas of rarefaction which expand the shell of bone to paper-like thinness, giving a cystic appearance resembling giant cell tumor. In angioma, however, the loculations are somewhat smaller and within them there is a fine fibrillary framework. The cortex is usually not expanded as in giant cell tumor or bone cyst

5. Treatment consists of irradiation or operation or both. The danger of severe hemorrhage from operation must be considered, especially in operations on the cranium and spine. Meyerding found angioma of bone to be somewhat radiosensitive, and under moderate dosage repeated at regular intervals for a number of months it gradually regresses until healed.

Malignant Angioma. Histologically, the malignant angiomas may be divided into two groups, the angio-endothelioma and the angiosarcoma.

1. *Angio-endothelioma.* A résumé of current opinion indicates that the question whether angio-endothelioma of bone exists as a pathological and clinical entity is still a controversial one although the evidence suggests that such a tumor of bone does occur. It is an angioblastic tumor but with an epithelium-like structure difficult to distinguish from metastatic carcinoma. Geschickter and Ewing state that angio-endotheliomas are usually found in the ends of long bones. The roentgenogram shows nothing which can be considered diagnostic. There is rarefaction and destruction, and rarely, bone production. Some reveal well defined septa.

2. Angiosarcoma. There seems to be almost as much confusion associated with the angio-

sarcoma group of vascular tumors as with angio-endothelioma. The author defines these tumors as those showing proliferating vascular endothelium with new blood vessel formation in which the vasoformative tendency is the predominant feature. The clinical and roentgenographic signs are in no way distinctive, being of little value in differentiating angiosarcoma from other malignant bone tumors.—*Mary Frances Vastine.*

Anderson, Carl E., and Saunders, John B. de C. M. Primary adamantinoma of the ulna. *Surg., Gynec. & Obst.*, Sept., 1942, *75*, 351–356.

The authors believe that the case reported is the first recording of this tumor in a long bone other than the tibia.

The adamantinoma is an infiltrating epithelial tumor, arising from basal cells. It grows in a stroma of fibrous tissue and reproduces, to a certain extent, the histological characteristics of the primitive tooth bud.

Pathologically, the tumor is a soft, spongy, gray, indistinctly lobulated, vascular growth which occupies the central portion of the shaft of the bone and expands it without breaking through the cortex.

Clinically, adamantinoma of the long bones exhibits the following characteristics: (1) it possesses a limited type of malignancy. It may erode the bone to a considerable extent but it will not invade adjacent tissues or metastasize; (2) either males or females may develop the tumor. The age incidence is from twenty-two to forty-six years; (3) the chronicity and slow growth of the tumor are noteworthy; the time elapsing between discovery of the tumor and surgical treatment in the reported cases has varied from ten months to sixteen years with the occurrence of only local extension; (4) all patients give a definite history of trauma; (5) aching pain is often noted but the usual presenting symptom is the presence of a tumor mass. Tenderness, increased local temperature, edema and fluctuation may be present in some instances; (6) the tumor has a very strong tendency to recur if not completely removed. (7) radiosensitivity of the tumor is low.

The treatment is complete surgical excision, resection, or amputation.

Roentgenologically, the tumor appears as a polycystic, expanding central tumor with sharp outlines and a fine trabecular pattern. No periosteal reaction or new bone formation is seen. There are no worn or eroded margins. A fine honeycombed appearance is often seen which is not usually present in bone cysts or giant cell tumors.—*Mary Frances Vastine.*

Vinke, Theodore H., and White, Edgar H. Congenital narrowing of the lumbosacral space. *Surg., Gynec. & Obst.*, May, 1943, *76*, 551–555.

In roentgen interpretations of the painful low back, increasingly greater emphasis is being placed upon the finding of a narrowed lumbosacral intervertebral space. For the past several years, it has been stressed that such a narrowing usually resulted from a herniation of the nucleus pulposus. However, this is no longer felt to be true. A narrowing of the intervertebral space at the site of a ruptured disc probably occurs in only a small percentage of cases. In fact, it has been shown that narrowing often occurs at a different level than the site of extropulsion as found at operation.

Another explanation for the narrowing of the lumbosacral intervertebral space is the disintegration of the annulus fibrosus and nuclear material incidental to the wear and tear of life. The concept is particularly reasonable since such narrowing is seen in those backs which, through structural anomalies, are mechanically weaker than normal. Incomplete sacralization, asymmetrical facets, an acute lumbosacral angle, and defects in the posterior elements, all make a relatively vulnerable joint unstable.

The incidence of congenital narrowing of the intervertebral space occurs often enough to be of diagnostic significance. The authors reviewed the roentgenograms of the lumbosacral junction in 300 children and 3 such cases were found. It was believed that any narrowing occurring in this age group (five to fifteen years) not resulting from such obvious pathological processes as tuberculosis, sclerosis, osteochondritis, or osteomyelitis must be of congenital origin. Roentgenograms of these cases revealed associated anomalies, lumbarization or sacralization being present in all instances.

Six case reports are given in all of which there was narrowing of the lumbosacral intervertebral disc but in which the pain could be adequately explained on a basis other than that of a herniated disc. The absence of leg signs or reflex changes plus an excellent response to conservative management constituted the evidence

against a pathological process of the disc.—*Mary Frances Vastine.*

Lee, Harold G., and Horan, Thomas B. Internal fixation in injuries of the ankle. *Surg., Gynec. & Obst.*, May, 1943, *76*, 593–599.

This paper classifies those injuries of the ankle that are operative. Operative reduction, when indicated, should be carried out as soon as possible, preferably within from twenty-four to forty-eight hours after the injury. The operative treatment which is required in each instance is outlined.

Fracture of the Lower End of the Fibula. The lower fibula may be fractured as the result of forcible external rotation of the foot or of turning the foot directly outward on the leg. The astragalus as it twists in the joint mortise and strikes against the edge of the external malleolus is the shearing force that causes the fracture. Such a fracture is the typical injury received in skiing when the point of the ski, turned outward, catches in the snow, and the skier pitches forward, twisting the ankle. The fracture line is usually oblique from side to side or extends as a long fracture line with its center at the joint surface. The exact circumstances under which operation is indicated in fractures of the lower end of the fibula are outlined.

Trimalleolar Fractures. The trimalleolar fracture, consisting of fractures of the posterior tibial surface and both malleoli, presents no problem when the triangular-shaped fragment of the tibia is small in size. However, when a large fragment is separated, it is difficult to reduce the fracture and to maintain the fragment in the corrected position. Disability is particularly marked in women, who are most likely to sustain this fracture, because of the fact that when high heels are worn the weight-bearing line falls through the posterior half of the tibial surface.

Fracture of the Anterior Tibial Surface. A fracture of the anterior weight-bearing surface of the tibia in which a wedge-shaped fragment is broken off and the foot displaced forward, requires operative reduction. This fracture is practically always of the comminuted type.

Fracture of the Internal Malleolus. Occasionally in an isolated fracture at the base of the internal malleolus, an obstacle to closed reduction is presented by a curtain of soft tissue that is interposed between the tibia and the fractured malleolar surface. If such a fracture is not accurately reduced, a fibrous union takes place, causing the area to be tender and painful and the joint mortise to be unstable.

Pott's Fracture. Another obstacle to reduction (one obstacle was discussed in the preceding paragraph) in Pott's fracture is the dislocated posterior tibial tendon.

Separation of the Tibia and Fibula. A separation of the tibia and fibula as the result of the tearing of the tibiofibular ligament may occur in conjunction with a fracture in the region of the ankle or as a separate entity. If the condition is not recognized, disability may ensue from the disrupted relation between the astragalus and the tibia by the widening of the ankle mortise.

Separation of the Lower Epiphysis of the Fibula. In this epiphyseal injury, the fragment is rotated backward, with the tip of the fibula acting as a fulcrum, and it occasionally takes with it a jagged spicule of bone from the fibular shaft. Reduction by closed methods is prevented both by the fulcral end of fibula and spicule of bone.

Recurrent Dislocation of the Peroneal Tendons. Recurrent slipping of a peroneal tendon over the lower end of the fibula is accompanied by an uncomfortable jarring snap from which the patient seeks relief.—*Mary Frances Vastine.*

Miller, Donald S., and de Takats, Geza. Posttraumatic dystrophy of the extremities; Sudeck's strophy. *Surg., Gynec. & Obst.*, Nov., 1942, *75*, 558–582.

Sudeck's atrophy was first described by Sudeck in 1900. Shuele found an incidence of posttraumatic dystrophy as high as 5 per cent among 500 cases of sprain. It is believed that if the diagnosis of this syndrome is made early enough a long standing disability may be avoided. There are certain criteria which make for correct diagnosis:

1. Persistent pain of a burning character with paroxysmal aggravations presented by a patient whose injury is properly immobilized, noninfected and seemingly on the way toward a normal course of repair, should make one suspicious of an early beginning reflex dystrophy.

2. The extremity is warm and there is edema of the subcutaneous tissues and joint capsule.

3. Osteoporosis does not occur until several weeks after the injury. There is spotty decalcification of the small bones of the hand or foot and in the metaphysis of long bones where vas-

cularity of the bone is the greatest. Later, the mottled, spotty bone atrophy becomes diffuse at which time it is indistinguishable from osteoporoses of other origin. It must be emphasized that the diagnosis should not be made on the basis of roentgenograms alone. The syndrome may be present without roentgen evidence or it may be subsiding when the bone changes are at their height. The greatest value of the roentgenograms lies in serial examinations.

Differential Diagnosis.

1. Atrophy of disuse. This is painless and not associated with marked vasomotor phenomena. Bone atrophy is diffuse, comes on slowly and improves on resumption of activity of the part.
2. Bone atrophy due to inflammation of joints. There is usually actual destruction around the joint in these cases.
3. Aseptic necrosis of bone. A rarefaction of bone is seen in the aseptic necrosis following vascular occlusions.

Prevention.

1. Careful attention to injuries affecting ligaments, tendons, and musculature as well as bone.
2. Early and adequate control of pain.
3. Alleviation of the patient's fear and anxiety.

The authors have done over 100 blood flow determinations on 12 patients. In posttraumatic dystrophy, an increased blood flow to the part has been demonstrated. A total of 33 patients suffering from early, intermediate, and late stages of the disease is reported.—*Mary Frances Vastine.*

Bothe, Frederick A., Simpson, H. Murray, and Rowntree, Leonard G. Traumatic and spontaneous fractures in exophthalmic goiter. *Surg., Gynec. & Obst.*, Sept., 1942, *75*, 357–360.

To date, only 7 cases of spontaneous fracture in cases of exophthalmic goiter have been reported. In the majority of instances in which it has occurred, the hyperthyroidism has been marked, long continued, and accompanied by extreme demineralization and decalcification of the bony skeleton.

The case reported constitutes the only one in which both traumatic and spontaneous fractures have occurred following earlier partial removal of the thyroid gland.

Von Recklinghausen first described the demineralization of the skeleton in a case of hyperthyroidism in 1891. Aub *et al.* reported an increase in the excretion of calcium and phosphate in clinical hyperthyroidism. They found the average excretion in cases of thyrotoxicosis 231 times greater than that in a normal individual. The serum phosphatase has been found to be elevated in cases of hyperthyroidism. Pain is the outstanding symptom associated with the skeletal changes. The pain is relieved following thyroidectomy but the recalcification of the skeleton is a very slow process.—*Mary Frances Vastine.*

Lee, Harold G. Fractures of the humeral condyles in children. *Surg., Gynec. & Obst.*, July, 1942, *75*, 97–102.

Thirty-two cases of fractures of the humeral condyles in which the end-results were studied are reviewed. In the series of 32 cases there are 13 fractures of the lateral condyle, 16 fractures of the medial epicondyle, 2 of the less common fractures of the internal condyle, and 1 of the rare fractures of the lateral epicondyle. Open intervention is the accepted method of treatment of these fractures. However, as is generally true when condylar fractures are treated conservatively, satisfactory functional results were obtained by closed methods in many of the cases in this series.

The roentgenographic study of the end-results were interesting:

(1) *Fractures of the External Condyle.* In the fractures that had been treated operatively, a well developed condyle in good position was seen. The fractures that had been handled conservatively showed an enlarged condyle with non-union or malunion.

(2) *Fractures of the Medial Epicondyle.* Roentgen studies of the end-results in these fractures usually showed an enlarged fragment that had pulled away from its bed. These changes were observed in cases that had been treated either operatively or conservatively. It is difficult to explain such findings in cases that have been reduced accurately. Proliferative islands of bone showed around the outer margins of the joint in most of the fractures involving the medial epicondyle. Then, too, failure of union between the medial epicondyle and the humeral shaft, which normally takes place about the eighteenth year of life, was noted in most instances. Of particular interest in the

roentgenograms of 2 cases of operative excision of the medial epicondyle were islands of bone that suggested regeneration.—*Mary Frances Vastine.*

SACHS, MAURICE D., and HILL, HAROLD A. Complications of infero-anterior (axillary) dislocation of the shoulder joint as demonstrated by roentgenograms. *Surg., Gynec. & Obst.*, Nov. 1942, *75*, 639–646.

The authors believe that the mechanism of the infero-anterior dislocation is as follows: The arm is abducted and internally rotated. Trauma is transmitted along its longitudinal axis, forcing the head inferiorly under the inferior lip of the glenoid (subglenoid dislocation). The lateroposterior portion of the humeral head impinges on the glenoid lip as it is forced anteriorly through the capsule into the axilla.

Complications of the inferoanterior dislocation include: (1) The so-called compression defect in the lateroposterior head of the humerus. This is best seen when the roentgenogram is taken with the arm in internal rotation. A sharp vertical line of condensation extending downward from the top of the head of the humerus, parallel and slightly lateral to the shaft axis, comprises the medial border of the defect. (2) Fracture of the greater tuberosity. This is produced by impingement of the glenoid lip of the tuberosity. (3) Fracture of the inferoanterior lip of the glenoid. (4) Cystic changes in the head of the humerus. (5) Cystic changes in the region of the bicipital groove. The authors describe the roentgenologic technique they have developed for demonstrating this groove. The result is a tangential view of the shoulder in which a smooth notch is seen in the center of the humerus (the bicipital groove). On each side of the groove are prominent walls of the lesser and greater tuberosities.—*Mary Frances Vastine.*

ODGERS, S. L., and HARK, F. W. Habitual dislocation of the shoulder joint. *Surg., Gynec. & Obst.*, Aug., 1942, *75*, 229–234.

Tears in the capsule of the shoulder joint under the subscapularis can be demonstrated in the dissecting room. Their location varies slightly, some being between the middle and inferior glenohumeral ligament, some between the glenoid ligament and the rim of the glenoid fossa, a few being humeralward to the inferior glenoid ligament. This pathological picture is consistently found in the so-called direct force dislocation of the shoulder joint which is the forerunner of the habitually dislocating shoulder. Repair of this rent seems to be the proper treatment for preventing subsequent dislocations.—*Mary Frances Vastine.*

MOREL, MERVYN P. A case of spina bifida occulta of the 12th dorsal and 1st lumbar vertebrae. *Brit. J. Radiol.*, May, 1942, *15*, 154.

A case of the above-named anomaly is described and illustrated with a roentgenogram. The patient was a young man, aged twenty-one, who complained of pain in the right lower abdomen. Appendectomy had been performed without relief. Deformity of the spine was found on examination and a roentgenogram showed spina bifida occulta of the twelfth dorsal and first lumbar vertebrae. There was also a spina bifida occulta of the fifth lumbar vertebra. As the pain did not interfere with the patient's work he was discharged.

This is a rare anomaly. Walker and Bucy examined 5,967 roentgenograms of the twelfth dorsal vertebra and 6,290 roentgenograms of the first lumbar and found spina bifida occulta once in each series. The condition apparently had no clinical significance in the above-described case.—*Audrey G. Morgan.*

CAMPBELL, R. J. C. A case of osteochondritis disiccans occurring in a young soldier accepted for military service. *Brit. J. Radiol.*, May, 1942, *15*, 138–140.

A case of osteochondritis dissecans seen in Iceland in a soldier twenty-six years of age is described. He gave a history of having sprained his ankle some six years ago and at the same time the left knee was flexed under him. Some time later he began to compain of pain in the knee. Though he reported this knee complaint he was accepted for military service but since coming to Iceland has never been able to endure long marches.

The roentgen findings in this condition are characteristic. The roentgenogram of this case is given. It shows an oval shadow, denser if anything than the surrounding bone. This oval structure is surrounded by a narrow translucent zone of decalcified bone.

In these cases there may be separation of bone fragments, or joint mice, or separation

may not yet have occurred. If it has not immobilization and rest in bed should be tried for several weeks. If the fragment has separated operation is indicated.

The author believes this lesion is particularly well seen in the lateral view, while Liebman and Iseman believe it is best seen in the anteroposterior view and is apt to be overlooked entirely in the lateral view.—*Audrey G. Morgan.*

Rolleston, H., Orton, G. H., and Russ, S. The use of x rays in the manipulation of fractures of the extremities. *Brit. J. Radiol.*, Feb., 1942, *15*, 63–64.

The taking of roentgenograms should be the usual means used in the examination of fractures but in exceptional cases the manipulation of such fractures under screen control may be necessary. This is a dangerous method for the surgeon at best and if he takes the risk he must do it on his own responsibility. Such work should be performed only by senior surgeons.

The operating room should be satisfactorily darkened. The previous roentgenograms of the case should have been seen and memorized, and not examined in the bright viewing box immediately before the manipulation. The apparatus should be operated by a technician who has had special training for this work, and he should keep a log book recording the factors with actual times of screening involved. The tube-screen distance should not be less than 20 nor more than 30 inches. The apparatus should not be set at more than 65 kv. and 2 ma. An automatic cut-out can be incorporated in the set which will cut out if these factors are exceeded. All apparatus should be shock-proof. An integrating time switch is useful. All exposures should be made with a timing device. The fluorescent screen, faced with lead glass, should be of modern manufacture and in good condition. The hands of the operator or his assistants must not come within the direct beam. The cryptoscope (a fluorescent screen fitted to the head and supplied with a hood) is very dangerous and should never be used.—*Audrey G. Morgan.*

Samuel, Eric. Some minor injuries of bones and joints. *Brit. J. Radiol.*, March, 1942, *15*, 77–84.

Young adults, particularly in military life, frequently suffer minor injuries of bones and joints, frequently repeated. It is important to recognize these injuries as some of them are comparatively harmless and others may lead to serious disease in later life if not properly treated. Cases of a number of these injuries are described and illustrated with roentgenograms. The commonest minor lesion of bone is simple periostitis which can be differentiated from subperiosteal new growth by the fact that the cortex beneath it is unchanged. A second form of minor injury is myositis ossificans caused by tears in the periosteum. Injuries may be caused by a group of fractures variously known as insufficiency fracture, fatigue fracture or march fracture. These are frequently met with in army training.

The commonest minor injury to a joint is acute sprain. This is generally caused by a partial tear of one of the ligaments. The tear usually heals by fibrous tissue but sometimes calcification occurs at the site of the injury. It is important to differentiate between end-results, such as calcification, and the changes due to an active process such as osteochondritis dissecans. The latter is the commonest injury of joint cartilage. It is seen more frequently in the medial condyle of the knee than elsewhere. Oblique views of the knee joint should be taken when it is suspected and serial roentgenograms are also important. A rarer form of injury following minor trauma is avascular necrosis of a part of a bone, known as Panner's disease. Recurrent effusions into the knee joint may occur from damage to the menisci or cruciate ligaments. This results in thickening of the synovial membrane and disuse atrophy of the bones. This coarse atrophy can be differentiated from the fine homogeneous atrophy generally seen in tuberculous joints.—*Audrey G. Morgan.*

ROENTGEN AND RADIUM THERAPY

Adair, Frank E. Role of surgery and irradiation in cancer of the breast. *J. Am. M. Ass.*, Feb. 20, 1943, *121*, 553–559.

Adair reviewed the operable cases of cancer of the breast seen at Memorial Hospital from 1920 to 1936, inclusive, of which there were 1,996.

For purposes of the study he determined to: (1) Evaluate radiation therapy as the sole agent in the cure of mammary cancer. (2) Evaluate radical surgery alone. (3) Evaluate the combination of preoperative irradiation together with radical surgery. (4) Evaluate the combination of immediate radical surgery and postoperative

irradiation. (5) Evaluate the combination of simple mastectomy with axillary irradiation.

All of the breast cases were classified as follows:

I. Malignant tumors of the breast:
   Carcinoma:
      1. Primary operable.
      2. Operable after a local excision.
      3. Primary inoperable.
      4. Recurrent inoperable.
      5. Prophylactic.
   Sarcoma:
II. Benign tumors of the breast.
III. Lesions due to injury.
IV. Inflammatory diseases of the breast.

Since 1933 the base of operability has been broadened. That is, many patients who were formerly considered totally inoperable are now being treated by combined surgery and irradiation, because investigation reveals that irradiation failed to cure them. It is now known that in mammary cancer, if there is much actual bulk to be handled by radiation therapy, it will fail.

For a period of six years every patient whose condition was operable was subjected to preliminary irradiation routinely without any suggestion of "selectivity." When one compares the results when patients are treated in this way with treatment by immediate radical mastectomy followed by irradiation a month or six weeks later, one finds that the cure rate is higher among those treated by the latter method. To the author's mind this phase of the controversial problem of the value of preoperative irradiation is definitely settled. He believes that one reason for the fact that cases treated by preoperative irradiation followed by surgery do not have as high a cure rate as those treated by immediate surgery and then postoperative irradiation is the loss of time necessary for the irradiation to be given. In all probability the good done by the preoperative irradiation is more than overcome by the loss of time resultant from delivering the dosage and waiting for the skin damage to repair.

The only criterion for effectiveness in therapy is the percentage of the total number salvaged. During the first five years, 1920 to 1924 inclusive, only 8 per cent of the total breast cancer material obtained a five year salvage. In explanation of this Adair suggests first that the patients are coming to the surgeon earlier in the course of their disease as a result of education on the subject of cancer on the part of women. Second, as a result of coming earlier there is less bulk of axillary involvement with greatly increased opportunity for cure. Third, by experience we no longer are referring a patient with only a moderate opportunity for cure by surgery to the roentgen department, where there is less opportunity for cure. Fourth, the cure rate has gone up in those cases in which there is axillary involvement, because irradiation is here of decided value, particularly in groups 3 and 4 (on the malignancy scale). Not only does irradiation have a direct inhibitory effect on the remaining cancer cells; probably more important is the locking-up process of the cancer cells in the added scar and fibrous tissue as a result of irradiation.

In considering the amount of irradiation desirable as a postoperative procedure common sense should be our guide. A sufficient amount should be given to control the residual axillary disease and at the same time not enough to produce lymphedema of the arm. If there is a moderate amount of axillary involvement a total of 1,800 to 2,000 roentgens is given. If there is a large amount of axillary disease, with cancer spread over as far as the costoclavicular ligament 2,000 to 2,250 roentgens may be given.

In summarizing, the writer says this study shows that the preferable method of treating operable breast cancer is immediate radical mastectomy combined with postoperative irradiation. The poorest end-results obtained in this study were in those unselected cases given irradiation only.—*S. G. Henderson.*

KAPLAN, IRA I. Irradiation of the spleen and pituitary for control of puberal bleeding. *J. Am. M. Ass.*, April 10, 1943, *121*, 1199–1201.

Kaplan states that an entirely unwarranted fear that irradiation may do harm to the generative organs is one of the main reasons why this well tested method is not more generally utilized in the treatment of irregular bleedings in young girls. When roentgen therapy is properly employed, permanent suppression of ovarian function and damage rarely occur. Streeter is quoted as saying that the more primordial the cells the more resistant they are to roentgen irradiation, whereas ova in the later stages of their differentiation are easily destroyed by roentgen irradiation, and the primordial cells which will produce their

successors are perhaps not so easily affected. Roentgen treatment that the patient receives may kill off all the follicles but in the course of time the primordial ovarian tissue produces new crops of eggs along with their accessory cells and this finally results in the resumption of menstruation.

Treatment over the spleen can be administered without much danger of affecting the ovaries, the indirect effect on the ovaries being considerably less than the supposed damage resulting from direct ovarian irradiation in young women and girls. In menorrhagia at puberty or just beyond this period, roentgen therapy to the spleen and on the pituitary can be safely administered without interfering with subsequent ability to bear children.

The author cites the case of a young woman suffering from irregular menstrual bleeding and hemorrhage for nine years, previously treated with medication without response. The condition was moderately controlled by roentgen therapy to the spleen and pituitary and she eventually resumed normal menstruation. She married at the age of twenty-two and gave birth to a perfectly normal child about two years later.—*S. G. Henderson.*

Taylor, Howard C., Jr., and Greeley, Arthur V. Factors influencing the end-results in carcinoma of the ovary; report of a series of 138 patients treated from 1910 to 1935. *Surg., Gynec. & Obst.*, May, 1942, *74*, 928–934.

The authors reviewed 198 cases of ovarian tumor including 138 cancers of the ovary and 60 papillary cystadenomas. The principal factors which may vary the actual end-results as well as the figures as reported include:

1. *Gross Extent of Disease.* It is well recognized that the gross extent of the ovarian carcinoma at the time the operation is undertaken is the most important single consideration in prognosis.

2. *Types of Ovarian Tumor.* The granulosa cell tumors and dysgerminomas have a relatively favorable prognosis. In the largest group, the papillary serous and pseudomucinous adenocarcinomas, 88 in number, there was a five year cure rate of 15.9 per cent.

3. *Histological Degree of Malignancy.* The differentiated tumors of perhaps doubtful malignancy had a very much better prognosis than the others.

4. *Radiation Therapy.* Postoperative roentgen treatment of ovarian cancer was begun at the Roosevelt Hospital in 1928. For the first three years the therapy consisted in a single high voltage treatment given to each of four fields. From 1931 to 1933, four pelvic fields were treated, each receiving 670 r in one dose. From 1933 to the present time, four fields have been used, each receiving five exposures of 300 to 360 r at each treatment.

Postoperative roentgen therapy was apparently responsible for the five year cure of 2 cases in which recurrence was otherwise certain, but the effect of roentgen irradiation on the percentage of five year cures and on survival curves was less than has been frequently claimed.—*Mary Frances Vastine.*

Donovan, M. S., and Warren, Shields. Persistence of tumor after preoperative radium treatment for cancer of the corpus uteri. *Surg., Gynec. & Obst.*, June, 1942, *74*, 1106–1111.

This work is summarized as follows:

1. Radiation therapy has won for itself an important place in the treatment of carcinoma of the body of the uterus. In the inoperable and technically operable groups of patients it is the only curative form of treatment available, and it provides about 10 per cent and 30 to 50 per cent five year survivals in these respective groups.

2. In the operable group of patients there has been a widespread opinion for some years that preoperative irradiation, chiefly by means of intrauterine radium, followed by hysterectomy and salpingo-oophorectomy one to two months later, would accomplish a higher percentage of cures than either irradiation or surgery alone. Accordingly, this has been advocated as the method of choice for treating this type of cancer.

3. More recent publications indicate doubt as to the wisdom of using preoperative radiation therapy as a routine measure in the operable cases. Good results have been obtained from a combination of surgery with postoperative roentgen irradiation.

4. Forty-six proved cases of carcinoma of the uterine body have been reviewed, all of which were treated by intrauterine radon and complete hysterectomy at least six weeks after the irradiation.

5. In only 5 cases was the uterus found to be free of carcinoma when removed.

6. This investigation does not throw light on the question of the value of irradiation in preventing vaginal metastases.

7. In deciding whether or not to use preoperative irradiation, the relative advantages of possibly destroying the tumor or decreasing its chance of implantation must be balanced against the delay and inconvenience to the patient.—*Mary Frances Vastine.*

CUTLER, MAX. Complications of radiotherapy in cancer of the cervix. *Surg., Gynec. & Obst.*, April, 1942, *74*, 867–870.

The complications which may be met in the treatment of cancer of the cervix with radium and roentgen radiation include:

1. *Occlusion of the Cervical Canal.* Occlusion of the canal by the growth renders introduction of radium (which is the usual initial procedure) difficult and sometimes impossible. This difficulty can be obviated by initiating the treatment with external and vaginal irradiation. Regression of the lesion will follow so that the cervical canal can be located for insertion of radium without undue trauma and with no danger of perforation.

2. *Injury to Skin and Subcutaneous Tissues.* Early injury to the skin consists of an "epidermite" which expresses itself as a moist denuded surface caused by a complete loss of the superficial layers of the epidermis. Late skin injury consists of telangiectasis, atrophy and, in extreme cases, ulceration. The production of the "epidermite" should be avoided by protracting the total duration of treatment to five or six weeks and by adhering to the other principles of adequate filtration, limited surface areas, and low intensity.

Connective tissue damage, including injury to blood vessels, shows itself in the form of edema. This may appear within twenty-four hours of treatment or it may occur later during the irradiation. It is an indication for immediate reduction in the intensity of treatment.

3. *Injury to Blood.* The general apprehension regarding the dangers to the blood forming organs accompanying massive irradiation for cancer of the cervix is not supported by the most authentic evidence. All difficulties can be avoided by identifying the occasional patient with hypersensitivity to irradiation of the white blood cells.

4. *Injury to Bladder.* Serious damage to the bladder can occur only as a result of faulty irradiation.

5. *Injury to Rectum.* The rectal mucosa is one of the most radiosensitive tissues in the body. The first reaction is usually a watery diarrhea with two to four liquid stools daily, which comes on during the third week of external irradiation when a little less than half of the treatment has been completed (4,000 r or 150,000 mg-hr.). The only change in treatment required by this reaction is a reduction in the size of the skin field. If the rectal reaction becomes more severe, the daily dose must be reduced or the size of the field diminished or the treatment discontinued for several days or longer. A profuse, severe diarrhea accompanied by colic-like pain is due to overdosage and should be avoided.

6. *Late Post-irradiation Sclerosis of Pelvic Tissues.* Late sclerosis of the pelvic tissues may occur years after intensive irradiation for cancer of the cervix. This state may be accompanied by occlusion of the vagina and cervix followed by pyometra, vaginal sclerosis, rectal obstruction, and occlusion of the ureters followed by pyelonephrosis or pyelonephritis.

7. *Post-irradiation Intestinal Obstruction Resulting from Benign Stricture of Intestine.* This complication, although rare, is of the greatest importance. Unless it is considered, a diagnosis of recurrence is usually made. The clinical picture is classically that of intestinal obstruction.

8. *Localized Infection.* This may be divided into three groups: (*a*) early pyometra which appears toward the end or within several weeks after irradiation; (*b*) late pyometra which occurs from one to several years after treatment; (*c*) late infectious parametritis which arises one to three years after radiation treatment.

9. *Localized and Generalized Infection during Irradiation of Cervical Cancer.* Infection during the process of irradiation is by far the most important complication associated with the radiotherapy of cancer of the cervix, the 2 per cent mortality charged against this procedure being due almost exclusively to the activation of hemolytic streptococci by the irradiation. The incidence of hemolytic streptococci in cervical cancer is variously reported by different authors. Virulent hemolytic streptococci are probably less frequent in early lesions. A bacteriological examination should be made in every case before treatment as the infected cases re-

quire special attention.—*Mary Frances Vastine.*

SCHEFFEY, LEWIS C., THUDIUM, WILLIAM J., and FARELL, DAVID M. End results in the treatment of carcinoma of the cervix, 15-year report, 1921–1936. *Am. J. Obst. & Gynec.*, June, 1942, *43*, 941–954.

Five and ten year end results obtained in the treatment of carcinoma of the cervix on the Gynecological Ward Service at Jefferson Medical College Hospital have already been published. This study adds 137 patients making a grand total for the fifteen year period of 293 patients seen and 277 treated with a follow-up figure of 97.2 per cent. Approximately 7 per cent of the lesions were classified histologically as adenocarcinoma, the remainder being squamous cell type.

Extent of Involvement. (1) 12 per cent were early cases; (2) 81 per cent were advanced cases; (3) 6 per cent had received primary treatment elsewhere.

These figures are discouraging for they would seem to show that patients seen with a relatively early lesion are comparatively rare.

Age, Incidence, Parity, Race. (1) 27 per cent of the patients exhibited cervical carcinoma before the age of forty; 57 per cent of the patients were between forty and fifty-nine years of age. The youngest patient was a twenty-two month old infant, the youngest adult was twenty-two and the oldest patient eighty-four; (2) 85 per cent of the patients were nulliparous; (3) 9.8 per cent of the patients were Negroes and 1.0 per cent were Jewish.

Results of Treatment. (1) The absolute salvage was 12.9 per cent (absolute salvage being the number of patients alive following treatment when the observation period is reported, based on the total number of patients actually seen). (2) The relative salvage was 13.7 per cent (relative salvage being the number of patients alive following treatment when the observation period is reported, based on the number of patients actually treated). (3) The five-year salvage was 23.1 per cent (the number of patients treated who have survived five years or longer but have eventually died of carcinoma, of an intercurrent condition, or of an entirely different malignant growth).

Note: The percentage of surviving patients who were over forty years of age when they received their initial treatment was about twice as large as the corresponding percentage of survivors under forty.

Treatment with Irradiation. The patients treated with both radium and roentgen irradiation presented superior survival rates. There is some evidence in favor of the hypothesis that those patients receiving preliminary irradiation show a higher salvage rate.

Carcinoma of the Cervical Stump. The incidence of carcinoma of the cervical stump was 4.7 per cent. The results of treatment in cervical stump carcinoma have been better than with carcinoma of the cervix in general.

Technique of Irradiation.

Radium: The technique has changed over the fifteen year period. Since 1938 three 50 mg. capsules screened with 1.5 mm. of platinum intracervically placed and ten 10 mg. needles screened with 0.5 mm. of platinum interstitially placed have been used. From 1928 until 1936, 3,600 mg-hr. was the dosage adminstered.

Roentgen Rays: Since 1938, two anterior and two posterior portals cross-firing on the uterus have been used. Two areas have been treated daily each receiving 200 r, measured in air. Treatments were continued until a well marked erythema was obtained (which will occur as a rule with a total of 1,600 to 2,400 r to each portal). Such a series requires about three weeks. Radium application has been delayed for two to three weeks following preliminary external irradiation.

Histologic Grading and Prognosis. The impracticability of attaching prognostic significance to the histologic grading of carcinomatous lesions of the cervix is noted.—*Mary Frances Vastine.*

MISCELLANEOUS

MUNRO, DONALD, and ELKINS, CHARLES W. Two-needle oxygen myelography; new technique for visualization of spinal subarachnoid space. *Surg., Gynec. & Obst.*, Dec., 1942, *75*, 729–736.

The authors have modified a technique for spinal air injections described by Chamberlain and Young in 1939. Instead of using a single needle, two needles are used and oxygen instead of air is employed as the medium for injection into the subarachnoid space.

One needle is placed low in the lumbar region and the other needle is placed at the desired cephalad level of fill. If the entire canal is to be visualized, the cephalad needle is placed in the

cisterna magna. As the patient's head is lowered, fluid will flow from the cephalad needle and as this occurs, oxygen is slowly injected into the caudal needle. It has been found that 20 to 30 cc. is sufficient to fill the lumbar area, 40 to 50 cc. the midthoracic and lumbar areas, and 75 to 100 cc. the entire spinal canal.—*Mary Frances Vastine.*

Boyd, Douglas. A simple radiographic table for Smith-Petersen pinning of the femoral neck. *Brit. J. Radiol.*, 1942, *15*, 94–95.

A table is described and illustrated which simplifies the taking of a lateral roentgenogram so necessary in pinning the neck of the femur. It is made of wood and any good joiner can make it. The body of the table is a heavy frame 4 feet long by 18 inches wide and 5 inches deep. The top is ¼ inch plywood. The legs are screwed into heavy metal sockets. One end of the table projects to form a cassette tunnel. The perineal post which usually interferes with lateral roentgenography is replaced by webbing straps. The tractor mechanism permits of fixation and inversion of the feet. Abduction is obtained by sliding the whole leg assembly laterally in a semi-circle and this can be done because the point that rests on the floor is covered with rubber and does not slip. The unit can be dismantled and packed in the back of a car in a few minutes and transported for emergency use. There is no difficulty in keeping clear of the field of operation during roentgenography. The cassette tunnel enables the film to be slid into position from the safe side of the table.—*Audrey G. Morgan.*

Halberstaedter, L., and Back, A. The effect of X rays on single colonies of Pandorina. *Brit. J. Radiol.*, April, 1942, *15*, 124–128.

This article from the Hebrew University of Jerusalem describes work in irradiating single colonies of the green alga, *Pandorina morum*, which is found in the waters of Palestine. It was found that immediate death followed doses of 300,000 to 600,000 r. Different colonies have different sensitivity but all the daughter cells of a single colony are killed by approximately the same dose. Colonies irradiated with doses of 3,000 to 300,000 r do not die immediately but delayed death occurs at the time of mitosis. Doses of less than 3,000 to 4,000 r do not cause any change in the colonies. Tables are given showing the details of the effects of single and fractional doses.

It has long been known that mitosis plays a prominent part in radiobiological reactions. The breakdown of irradiated cells at the time of mitosis also plays a part in the effects of irradiation on higher animals. It explains some therapeutic effects and delayed necrosis at long periods after irradiation.

While immediate death in *Pandorina* is only produced by extremely large doses, delayed death is caused by doses about 1/100 times as large and of a size similar to those used in the treatment of tumors in the human being.—*Audrey G. Morgan.*

Gray, L. H., and Read, John. The effect of ionizing radiations on the broad bean root. Part II. The lethal action of gamma-radiation. *Brit. J. Radiol.*, Feb., 1942, *15*, 39–42.

Details of the technique of two methods of testing the lethal effect of gamma rays on broad bean roots are described and a table given showing the number and percentage of survivals by each method. The degree of agreement between the results of the two methods is not satisfactory. The data from the second method seem to be more reasonable than those from the first and the authors believe the results deduced from it are to be preferred. A graph is given showing the sigmoid mortality curve and the distribution curve of sensitivities based on the results of this method.

From the results of the experiments the authors conclude that it is unlikely that the difference in shape between the gamma-ray and neutron-ray mortality curves on which they have commented in earlier papers is real.—*Audrey G. Morgan.*

Gray, L. H., and Read, John. The effect of ionizing radiations on the broad bean root. Part III. The lethal action of neutron radiation. *Brit. J. Radiol.*, March, 1942, *15*, 72–76.

This is one of a series of papers which record the results of a quantitative experimental study of one particular biological reaction to a variety of ionizing radiations. It compares the effect of neutron irradiation with gamma irradiation. The technique of the experiments is described and tables and curves given, together with the mathematical formulae used in the calculations. There is some uncertainty in the conversion

from ionization into energy units. Taking this into account the final result for the irradiation of beans by neutrons is: Mean lethal dose = 75 ± 16 energy units. The comparable value for gamma rays is: Mean lethal dose = 651 ± 46 energy units (or roentgens). The relative effectiveness of neutron and gamma ionization in causing the death of broad bean roots is therefore

$$\eta \frac{N}{\gamma} = \frac{\text{Mean lethal dose of } \gamma \text{ rays}}{\text{Mean lethal dose of neutrons}}$$

$$= \frac{651}{75} = 8.7 \pm 1.6.$$

—*Audrey G. Morgan.*

Neary, G. J. The absorption of the primary beta radiation from radium in lead and platinum and the specific gamma-ray dose at a filtration of 0.5 mm. of platinum. *Brit. J. Radiol.*, April, 1942, *15*, 104–109.

For many years it was believed that the primary beta radiation from a radium source was entirely absorbed by a filter of 0.5 mm. platinum, but during the course of some measurements made by the writer the question arose as to whether some of the primary beta radiation escaped unabsorbed from such a filter. He therefore decided to make a measurement of the effective range of the primary beta radiation in lead, as platinum was not available. The details of his experiments are described. He found that the range of beta radiation from radium in platinum is 0.53 mm. He found it very complicated to measure the primary beta radiation separately from the secondary beta radiation from the filter. But he concludes that for needles or flat applicators of 0.5 mm. platinum screenage the ionization of the primary beta radiation in the adjacent tissues is never more than a few per cent and in any case is much less than the ionization of the secondary beta radiation from the filter which has been investigated before.

The second part of the article deals with the measurement by the use of a graphite thimble chamber of the gamma-ray dose rate at 1 cm. from 1 mg. radium filter by 0.5 mm. platinum. The dose was found to be 8.4 e.s.u./cc./hr.—*Audrey G. Morgan.*

Herz, R. H. A photoelectric instrument measuring quality and quantity of x rays for radiographic purposes. *Brit. J. Radiol.*, April, 1942, *15*, 110–113.

The photocurrent from a barrier layer photocell is proportional to the incident light within a certain range of intensity. Therefore such a cell can be used to measure the light emitted from a fluorescent screen and hence indirectly to measure the roentgen-ray intensity under certain conditions. The development of a new kind of roentgen-ray measuring device is based on the relationship between the photocell current and photographic effect. The apparatus is described and illustrated. It consists essentially of two barrier layer photocells placed side by side and facing a fluorescent screen but separated from it by a lead glass filter. Each cell is connected to a ballistic galvanometer. As the radiation reaching one of the cells is filtered through copper the deflection of this galvanometer by the rays will be less than that of the other. Every change of roentgen-ray quality will change the ratio of the two galvanometer deflections. A special ratio meter has been devised to measure the ratio of the two galvanometer deflections. It is described and illustrated. With this meter the roentgen-ray quality and the photographically effective dosage can be measured with one deflection of a spot of light. A chart is given showing the values of the quality of roentgen rays as determined in this way. This method can be used with different types of generators. By including a calibrated photocell dosimeter on a roentgen-ray switchboard a basis for the standardization of roentgenographic values is obtained and at the same time instantaneous readings of quality (with various filters) and quantity.—*Audrey G. Morgan.*

Smithers, D. Waldron. The spatial distribution of x rays and total energy absorption: a consideration of the importance of these concepts in the x-ray treatment of cancer. *Brit. J. Radiol.*, Feb., 1942, *15*, 50–55.

In the treatment of deep cancer the rays must penetrate normal tissues to reach the cancer. Because of the decrease of dose with depth the normal tissues will be given a larger dose than the tumor unless multiple beams are used which overlap in the deep tissues so as to raise the dose to the tumor region. The chances for cure are best in localized tumors but their radiosensitivity is about the same as that of the

normal tissues. Every effort must be made to localize the large dose to the tumor and the total volume given a high dose must be kept as small as possible. Every device must also be used to increase the sensitivity of the tumor cells as compared to that of the normal cells around them.

In the past the dosage factors that have been considered of chief importance were: dose at the skin, tumor dose, quality of the primary radiation, dosage rate on the skin, time spacing of the treatment. Increasing emphasis has been placed lately on the maximum and minimum doses to the region involved and the development of methods of studying the distribution of radiation throughout the whole volume treated. In the past too much stress has been laid on skin tolerance and too little on the tolerance of the patient. The severe effects of irradiation and the tumor response are both related to the volume of tissue that is given a large dose. The damage to a tumor depends not only on the dosage given the tumor but on the changes produced in the surrounding tissues. The total energy absorbed has a profound effect on the dose that can be given a tumor and the effect on the tumor. Up until recently there has been no method of measuring the total energy absorbed throughout the body of the patient. It has now been found that the total energy absorbed can be estimated by a suitable extension of the system of dosage based on the international unit of dosage, the roentgen, combined with a consideration of the volume of tissue irradiated.

The roentgen is a measure of the energy absorbed by one gram of air and also a measure of the amount of energy absorbed per gram of soft tissue. The energy absorbed when one roentgen is given to one gram of tissue is one gram-roentgen. If for instance a dose of one roentgen is given to 10 cc. of tissue the integral dose is 10 gram-roentgens or if a dose of 6,000 r is given to 1,000 cc. the integral dose is 6,000 $\times$1,000=6$\times 10^6$ gram-roentgens, or 6 megagram-roentgens. The integral dose, that is the total body absorption, is found to vary greatly with the different treatment techniques. The statement that a patient has been given an integral dose of 5 megagram-roentgens should soon be as familiar as saying that a patient has been given 5,000 r.

The practice of directing several roentgen-ray beams at the center of the tumor is seldom the best arrangement. The determination of the volume distribution due to several angled fields is long and cannot be applied to each patient. It is used to decide the best arrangement in standard techniques. These arrangements ensure that the largest dose is limited to the tumor. Much of the value of the determination of volume distributions is lost if the beams are not directed accurately. Accurate beam direction can be assured by the use of such devices as those described by Mayneord and Dobbie.

A graph is given showing the treatment given one patient that shows the above-named factors. The maximum and minimum doses to the tumor are determined from the complete volume distribution. The graph shows the curve of the dose with time.—*Audrey G. Morgan.*

COOK, H. F. Note on the skin-dose measurement of radium moulds: gamma-ray back-scatter. *Brit. J. Radiol.*, 1942, *15*, 48–49.

A simple technique is described for measuring the back-scatter for increasing irradiated areas. To get the true dosage rate at the surface of a radium mould in position on a patient a correction for back-scatter from the mould must be made on the dosage rate as measured in air. The correction, which increases at first for the size of the area irradiated becomes constant at 6 per cent for areas greater than 100 sq. cm. A table is given showing the percentage increase in back-scatter and a curve showing the percentage increase in dose due to back-scatter plotted against area. The percentage back-scatter does not vary with varying radium-skin distances. Measurements at points other than the center of the irradiated area showed that the back-scatter was fairly uniform over the area, falling off only at the edge.—*Audrey G. Morgan.*